

APPENDIX A

Nine Key Elements

NINE KEY ELEMENTS

(Excerpted from “Nonpoint Source Program and Grants Guidance for Fiscal Year 1997 and Future Years,” U.S. Environmental Protection Agency, Office of Water, Washington, D.C., May 1996.)

EPA and the state lead nonpoint source agencies agree that the following nine key elements characterize an effective and dynamic state nonpoint source program. Each key element appears in bold type and is then followed by explanatory text that elaborates on the key element. The explanatory text provides information on means by which the states may choose to implement the key element.

All states will review and, as appropriate, revise their nonpoint source management programs in a manner that reflects these nine key elements. States will then submit their upgraded programs to EPA for approval. As discussed below in Sections III-B and V of this guidance, states that successfully incorporate these nine key elements into their programs and have a proven track record of effective implementation will be recognized Nonpoint Source Enhanced Benefits States and be provided maximum flexibility in implementing their programs and other benefits.

1. The state program contains explicit short- and long-term goals, objectives and strategies to protect surface and groundwater.

The state’s long-term goals are consistent with the national program vision that all states implement dynamic and effective nonpoint source programs designed to achieve and maintain beneficial uses of water. The shorter-term objectives consist of activities, with milestones, that are designed to demonstrate reasonable further progress that leads to accomplishment of the long-term goals as expeditiously as possible. The state program includes objectives that address nonpoint sources of groundwater pollution. The objectives list both implementation steps and the results to be achieved (e.g., water quality improvements or load reductions).

The state program includes long-term goals; shorter-term (e.g., 3- to 5-year) objectives that are periodically updated based on progress, strategies to achieve progress toward achieving the goals and objectives, indicators to measure progress and annual work plans to implement the strategies.

2. The state strengthens its working partnerships and linkages to appropriate state, interstate, tribal, regional and local entities (including conservation districts), private sector groups, citizen groups and federal agencies.

The state uses a variety of formal and informal mechanisms to form and sustain these partnerships. Examples include memoranda of agreement, letters of support, cooperative projects, sharing and combining of funds and meetings to share information and ideas.

The state nonpoint source lead agency works collaboratively with other key state and local nonpoint source entities in the development and implementation of the section 319 management program and actively involves them in decision making. Interagency collaborative teams, nonpoint source task forces and representative advisory groups have all proven effective for accomplishing these linkages, especially where they meet on a regular basis and are managed in a collaborative and inclusive manner.

Further, the state seeks public involvement and comment on significant proposed program changes and engages in public education activities to promote public awareness of nonpoint source pollution and its solutions. As appropriate, representatives are involved from local, regional, state, interstate, tribal and federal agencies; public interest groups, industries, academic institutions, private landowners and producers, concerned citizens and others. This involvement helps ensure that environmental objectives are well integrated with those for economic stability and other social and cultural goals.

3. The state uses a balanced approach that emphasizes both statewide nonpoint source programs and on-the-ground management of individual watersheds where waters are impaired or threatened.

The state nonpoint source management program emphasizes a watershed management approach and is well integrated with other important programs to protect and restore water quality. These include point source, ground water, drinking water, clean lakes, wetlands protection and national estuary programs; coastal zone programs; conservation and pesticide management programs; forestry programs; and other natural resource and environmental management programs.

Each state has the flexibility to design its nonpoint source management program in a manner that is best suited to attain and maintain beneficial uses of water. On-the-ground implementation of practices and programs is the best means of reducing and preventing pollution from nonpoint sources, but states may achieve this on-the-ground implementation by a combination of watershed approaches and state-wide programs. Similarly, as described more fully in key element 5 below, the state may use any combination of water-quality or technology-based approaches it deems appropriate to make progress toward attaining and maintaining beneficial uses of water.

4. The state program (a) abates known water quality impairments from nonpoint source pollution and (b) prevents significant threats to water quality from present and future nonpoint source activities.

The program is designed to remedy waters that the state has identified as impaired by nonpoint source pollution. Further, the program is designed to prevent new water quality problems from present and reasonably foreseeable degradation. State

programs should place a priority on protecting waters from future nonpoint source pollution as soon as possible (generally within 5 years).

5. The state program identifies waters and their watersheds impaired by nonpoint source pollution and identifies important unimpaired waters that are threatened or otherwise at risk. Further, the state establishes a process to progressively address these identified waters by conducting more detailed watershed assessments and developing watershed implementation plans, and then by implementing the plans.

The state identifies waters impaired by nonpoint source pollution based on currently available information (e.g., in reports under sections 305(b), 319(a), 303(d), 314(a) and 320, and revises its list periodically as more up-to-date assessment information becomes available. The state also identifies important unimpaired waters that are threatened or otherwise at risk from nonpoint source pollution.

In addition, the state identifies the primary categories and subcategories causing the water quality impairments, threats and risks. At 5-year intervals the state updates the identification of waters and their watersheds impaired or threatened by nonpoint source pollution, preferably as part of a single comprehensive state water quality assessment which integrates reports required by sections 305(b), 319(a), 303(d), 314(a) and 320.

The factors used by the state to progressively address its waters may include a variety of relevant environmental and administrative considerations, including, for example:

- human health;
- ecosystem health including ecological risk;
- the beneficial uses of the water;
- value of the watershed or groundwater area to the public;
- vulnerability of the surface or groundwater to additional environmental degradation;
- likelihood of achieving demonstrable environmental results;
- implementability;
- extent of alliances with other federal agencies and states to coordinate resources and actions; and
- readiness to proceed.

The state links its prioritization and implementation strategy to other programs and efforts as appropriate. Examples include total maximum daily loads, clean lakes programs, comprehensive groundwater protection programs, source water protection programs, wetlands protection programs, national estuary programs, ambient monitoring programs and pesticides management programs. Related programs administered by agricultural, forestry, highway and other agencies should also be linked, for example, USDA's Water Quality Initiative, PL-534 and PL-566 Watershed Projects and the Northwest Salmon Initiative. In establishing priorities

for groundwater activities, the state considers wellhead protection areas, groundwater recharge areas and zones of significant groundwater/surface water interaction.

More detailed information on priority setting is also contained in pp. 11 and 12 of the December 1987 Nonpoint Source Guidance; Setting Priorities: The Key to Nonpoint Source Control (EPA, 1987); Selecting Priority Nonpoint Source Projects: You Better Shop Around (EPA, 1989); Geographic Targeting: Selected State Examples (EPA, 1993) and Watershed Protection: A Project Focus (EPA, 1995).

6. The state reviews, upgrades and implements all program components required by section 319(b) of the Clean Water Act, and establishes flexible, targeted and iterative approaches to achieve and maintain beneficial uses of water as expeditiously as practicable. The state programs include:

- A mix of water quality-based and/or technology-based programs designed to achieve and maintain beneficial uses of water; and
- A mix of regulatory, non-regulatory, financial and technical assistance as needed to achieve and maintain beneficial uses of water as expeditiously as practicable.

Section 319(b) specifies the minimum contents of state nonpoint source management programs. These include:

- (i) An identification of the measures (i.e., systems of practices) that will be used to control nonpoint sources of pollution, focusing on those measures which the state believes will be most effective in achieving and maintaining water quality standards. These measures may be individually identified or presented in manuals or compendiums, provided that they are specific and are related to the category or subcategory of nonpoint sources. They may also be identified as part of a watershed approach toward achieving water quality standards, whether locally, within a watershed or state-wide;
- (ii) An identification of programs to achieve implementation of the measures, including, as appropriate, non-regulatory or regulatory programs for enforcement, technical assistance, financial assistance, education, training, technology transfer and demonstration projects. States should establish a flexible, targeted approach to solve their water quality problems. States have the freedom to decide the best approaches for solving the problems that they identify under key element 5 above. These approaches may include one or all of the following:
 - watershed or water quality-based approaches aimed at meeting water quality standards directly;

- iterative, technology-based approaches based on best management practices or measures, applied on either a categorical or site-specific basis; or
 - an appropriate mix of these approaches.
- (iii) A description of the processes used to coordinate and, where appropriate, integrate the various programs used to implement nonpoint source pollution controls in the state;
 - (iv) A schedule with goals, objectives and annual milestones for implementation at the earliest practicable date: legal authorities to implement the program; available resources and institutional relationships;
 - (v) If the state program is changed substantially, certification by the Attorney General or designee;
 - (vi) Sources of funding from federal (other than section 319), state, local and private sources;
 - (vii) Federal land management programs, development projects and financial assistance programs (see key element 7 below); and
 - (viii) A description of the monitoring and other evaluation programs that the state will conduct to help determine short- and long-term program effectiveness.

In addition, state nonpoint source programs must incorporate existing baseline requirements established by other applicable federal or state laws to the extent that they are relevant. For example, coastal states and territories should include or cross-reference approved state coastal nonpoint source programs required by section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990. In this manner, states can make sure that these coastal nonpoint source programs and other relevant baseline programs are integrated into section 319 programs, and that they are eligible for section 319(h) grant funding, which is limited by section 319(h)(1) to “the implementation of approved section 319 programs.”

All of these components should be identified by the state, included in the state nonpoint source management program and be reviewed and approved by EPA under section 319 of the Clean Water Act.

7. The state identifies federal lands and activities which are not managed consistently with state nonpoint source program objectives. Where appropriate, the state seeks EPA assistance to help resolve issues.

The state commits to reviewing and identifying those federal land management programs, development projects and financial assistance programs that are or may be inconsistent with the state’s nonpoint source management program.

As a federal agency, EPA has a special role to play in support of state nonpoint source programs by working with other Federal agencies to enhance their understanding of the significance of nonpoint source pollution and of the need to work cooperatively with states to solve nonpoint source problems. Where appropriate, EPA will help develop memoranda of agreement among states and federal agencies to help reduce nonpoint source pollution on federal lands and to better address nonpoint source pollution in federal assistance programs and development projects. In addition, where appropriate, EPA will assist in resolving particular issues that arise between the state and federal agencies with respect to federal consistency with the state nonpoint source management program.

8. The state manages and implements its nonpoint source program efficiently and effectively, including necessary financial management.

The state implements its program to solve its water quality problems as effectively and expeditiously as possible. Timeliness is key to accomplishing environmental objectives and demonstrating results as soon as possible. To help assure that priority water quality problems are addressed cost-effectively and in a timely manner, the state includes in its program a process for identifying the critical areas requiring treatment and protection within watersheds selected for implementation activities and assigns the highest priority to addressing those areas.

The state employs appropriate programmatic and financial systems that ensure that section 319 dollars are used consistently with its legal obligations and generally manages all nonpoint source programmatic funds to maximize environmental benefits. The state ensures that section 319 funds complement and leverage funds available for technical and financial assistance from other federal sources and agencies.

9. The state periodically reviews and evaluates its nonpoint source management program using environmental and functional measures of success and revises its nonpoint source assessment and its management program at least every five years.

In its upgraded program, the state establishes appropriate measures of progress in its programmatic and environmental goals and objectives identified in key element #1 above. The state also describes a monitoring/evaluation strategy and a schedule to measure success in meeting those goals and objectives. The state integrates monitoring and evaluation strategies with ongoing federal natural resource inventories and monitoring programs.

Appendix A presents a guide for evaluating the effectiveness of state nonpoint source management programs, based on these nine key elements. Approaches to environmental indicators and monitoring are described below.

a. Environmental Indicators

States are encouraged to use several sets of measures to fully indicate their success in implementing their nonpoint source programs. These include measures that indicate progress toward achieving and maintaining beneficial uses of water toward long-term goals (e.g., successfully implementing a particular technology).

Appendix B contains an illustrative set of indicators and other measures that can help the states and the public gauge the progress and success of their programs. States may identify and use other indicators and measures that are most relevant to their particular nonpoint source problems, programs and projects. However, states are strongly encouraged to use environmental endpoints to the greatest extent feasible so that the state and the public may best recognize the state's progress in addressing water quality problems in terms that are most relevant to the public's concerns. In addition, as discussed in Section IV-D of this guidance, states must include in its annual reports at least the three measures of progress that are identified in section 319(h)(11), including implementation milestones, available information on reductions in nonpoint source pollutant loadings and available information on improvements in water quality.

EPA is currently developing a broad strategy for the use of environmental indicators for its various environmental programs, including its water programs. The list in Appendix B, while providing more detail on indicators that are of particular relevance to state nonpoint source programs, is consistent with the environmental indicators adopted nationally by EPA to measure progress toward environmental goals.

b. Monitoring in Watershed Projects

Appropriate monitoring of watershed project implementation is an essential tool to enable states to identify nonpoint source pollution problems and to evaluate nonpoint source program effectiveness. First, states need to identify sources, document the effectiveness of individual measures and BMP systems and develop watershed-level strategies to prevent and control nonpoint source pollution. Second, in the case of watershed projects intended to demonstrate a new or innovative technical or institutional approach to resolving nonpoint source water quality problems, monitoring is needed to develop the information and data necessary to demonstrate the project's effectiveness and the applicability of the approach elsewhere. Third, monitoring is needed to help states meet the annual reporting requirements of the section 319(h)(11), especially information on reductions in nonpoint source pollutant loading and improvements in water quality. Therefore, an appropriate type of monitoring should be considered for watershed projects funded with section 319 grants.

Major watershed projects should include some form of tracking or monitoring to evaluate effectiveness. Watershed implementation plans should include clearly stated monitoring objectives and an evaluation strategy making clear what the state expects to learn as a result of its evaluation of the project. The evaluation approach may be tailored to the specific project, based on factors such as the project's size and objectives. Approaches that can be used to meet the project evaluation needs include ambient water quality monitoring (e.g., edge-of-field, small watersheds, multiple watersheds, in-lake, in-aquifer monitoring), beneficial use assessment (e.g., biological/habitat assessment, attainment of water quality standards), implementation monitoring (e.g., audits, activity tracking, geographic information system tracking of land use and land management), model projections and photographic evidence. Ambient monitoring and beneficial use assessment tracking should be included for projects wherever feasible.

While states may use Section 319(h) grant funds for monitoring activities for particular watershed projects, states are encouraged to also explore other approaches to conducting monitoring. For examples, the U.S. Geological Survey and the National Oceanic and Atmospheric Administration holds an array of ambient data and can provide support for various monitoring activities, and volunteer monitoring programs are a useful resource in many states.

APPENDIX B

Plan Development and Review

PLAN DEVELOPMENT & REVIEW

Development Process and Public Participation

Missouri's Nonpoint Source Management Plan was prepared by the Missouri Department of Natural Resources and approved by EPA in 1989 in response to the requirements of Section 319 of the federal Water Quality Act of 1987. Changes over the last ten years have prompted DNR to revise the plan to reflect current natural conditions and administrative procedures in Missouri. This revised plan is a product of the process followed and discussed below.

The Missouri Nonpoint Source Management Plan was and will continue to be developed with participation from nonpoint source partner agencies, organizations, and the public. This cooperative effort is fundamental to the success of this plan. Federal, state, and local agencies and private organizations were contacted through memorandum, meetings, email, and telephone conversations. This revision has proceeded over a three-year period with many work group meetings related to specific topics and many related documents taken into account. Representatives from each agency and organization were invited to participate in the Nonpoint Source Management Plan workgroup to develop the strategic plan, review drafts and comments, and to contribute information on their NPS related goals and objectives. Public involvement in the NPSMP was provided through the public notice and comment process. The general public was notified of the plan's availability through press releases and DNR's website. The public was able to obtain a hard copy from the Water Pollution Control Program or it could be viewed and printed from DNR's website. The Missouri Clean Water Commission was provided copies of each draft section at the time each was completed.

Review, Comments and Responses

A preliminary draft was provided for review to representatives of NPS partner agencies and organizations in the spring of 1998. A list of those representatives invited to participate in the review, comments received, and responses may be found at the end of this section. All comments were reviewed and changes were made to the draft where necessary. Only comments that were not incorporated into the draft are listed.

A second draft was provided for review to the public in February 1999. A list of those who requested copies of the plan or submitted comments is provided following the interagency review comments. All comments received and responses are also provided. Due to substantial changes to the document following this first public review period, a second public review period was opened in May-June 1999. Comments received during these two public review periods follow the list of comments received during the interagency review.

A final draft of the plan was presented for approval to the Missouri Clean Water Commission in July 1999. A commission approved draft was sent to EPA in August 1999 for final review and approval. EPA approved the final draft by October 1, 1999. Missouri's NPSMP will continue to be reviewed and updated using the framework outlined in the strategic plan.

INTERAGENCY REVIEW DISTRIBUTION LIST

* American Fisheries Society
 * Assistant Attorney General
 Conservation Federation of MO
 * DNR-Air Pollution Control Program
 * DNR-Division of Energy
 DNR-Division of Environmental
 Quality
 DNR-Division of Geology and Land
 Survey
 DNR-Environmental Services
 Program
 * DNR-Hazardous Waste Program
 DNR-Jefferson City Regional Office
 DNR-Kansas City Regional Office
 * DNR-Land Reclamation Program
 DNR-Northeast Regional Office
 * DNR-Public Drinking Water
 Program
 DNR-Soil and Water Conservation
 Program
 * DNR-Solid Waste Management
 Program
 DNR-Southeast Regional Office
 DNR-Southwest Regional Office
 DNR-St. Louis Regional Office
 DNR-Technical Assistance Program
 * JD Information Services
 Kansas City Water Services Dept.
 * Lincoln University Extension
 * Mark Twain National Forest
 * Metropolitan St. Louis Sewer
 Mid-America Dairymen Inc.
 MO Ag Industries Council, Inc.

MO Chamber of Commerce
 MO Corn Growers Association

MO Dairy Association
 * MO Department of Agriculture
 * MO Department of Conservation
 * MO Department of Health
 * MO Farm Bureau Federation
 MO River Communities Network
 MO Soybean Programs
 Monsanto Co- Q2F
 National Park Service
 * Novartis Crop Protection
 Ozark Mt. Center for Environmental
 Education
 * REGFORM
 Show-Me Clean Stream
 Springfield City Utilities
 * UMC Outreach and Extension
 * USDA-Farm Service Agency
 * USDA-Natural Resources
 Conservation Service
 US EPA Region VII
 US Fish and Wildlife Service
 * US Forest Service
 * US Geological Survey
 Watershed Committee of the Ozarks

*Agencies/organizations that participated in
 review

INTERAGENCY REVIEW COMMENTS AND RESPONSES

Comments received during the interagency review (Spring 1998):

Many comments and suggestions were received after the first review and most of them were incorporated into the plan. The comments listed below are those that were not incorporated into the plan or those requiring a response for some other reason. They are listed by section or topic following the outline of the plan. Comments are bolded and italicized. Some of the comments listed will be discussed further by the workgroup and may be incorporated into the plan at a later date.

NINE KEY ELEMENTS OF AN EFFECTIVE STATE PROGRAM

The Nine Key Elements on an Effective State Program is a guidance document provided by EPA and cannot be revised at the state level. Responses will be directed toward making the Missouri approach to meeting those elements fit the needs of the state.

Item 4. The last comment in this point should be: (generally within 10 years with biannual trends point the direction towards removing the known water quality impairment.) Five years may not be long enough to design the remedy program.

Item 4. Five years may not be sufficient amount of time for full implementation of a remedy program. Longer term programs may be necessary with short term benchmarks.

Response: When the Nine Key Elements were originally developed by a national NPS workgroup, there was a ten to fifteen year time frame outlined for bringing impaired waters back to fishable, swimmable, and drinkable state. Workgroup members recognized that schedule as being unrealistic and took out the endpoint. This element as it is currently written is intended to strongly encourage states to put in place within 5 years practices or controls necessary to prevent new or additional degradation while gathering necessary data on existing impairments and implementing management strategies to bring waters back into compliance

Item 6. “Regulatory” in the context of NPS programs under 319(b) should be the acceptance of a voluntary farm plan for agriculture implemented by farmers in the targeted watershed. This means that agriculture still needs the non-regulatory, financial and technical assistance as needed to achieve and maintain beneficial uses of water as expeditiously as practicable. It does not need command and control of land use.

Response: The Nine Key Elements have provided the flexibility for states to plan to achieve beneficial uses of water in whatever manner best suits the state so long as the time frames are reasonable. Missouri's NPS Plan contains a template for voluntary water quality management plans which can meet the requirements of TMDLs. It also contains goals and objectives which call for providing funding for technical and financial assistance to those in watersheds designated as priorities.

NPSMP GOALS, OBJECTIVES, AND MEASURES OF SUCCESS

Many of the comments on this section were directed at the strategic plans of the NPS partners. The strategic plans are presented verbatim and cannot be edited by DNR. Reviewers were directed to a representative of the agency and encouraged to contact them to address issues further.

(Partners' Goals, Pg 11 under evaluation plan) Emphasis of evaluation for community water supplies should not be based solely on atrazine SDWA compliance rather on all constituents listed for monitoring that is of concern for nonpoint contribution. (Theme 2, pg 12) Reduce the use of row crop pesticides by 5%..... What is the unit of measurement of 5%? Is it total pounds of active ingredient or acres applied etc.? (Part 3 of implementation plan pg 12) Low volume and low rate pesticide technology should only be one portion of demonstrations and trainings. Lower rates depending on the products does not necessarily equate to enhanced water quality. (Theme 4 pg. 24) Strike out the word "safe" and replace with "proper" (Objective A10 part 1, pg.31) strike out "state" and replace with new name "pesticide" so it reads Pesticide Management Plan.

Response: The comments you have made on this section refer to the strategic plans of University Extension and the Missouri Department of Agriculture. As such, we can not make changes to the document or address your questions adequately. University Extension will be revising their strategic plan this winter. If you would like the opportunity to participate and address the issues you raised you may contact Bob Broz, Water Quality Program Director, at (573) 882-0085. The Missouri Department of Agriculture just sent us an update of their strategic plan which will be incorporated into the next draft NPSMP. You may contact Sarah Tyree at (573) 751-2477 if you would like to address the issues you raised regarding their plan or have any further questions.

P1, 2008 goal: It seems somewhat strange that biocriteria won't be developed until 2008. How would you document that 25% of streams had reached goals of attainability? The measurement of attainability is very dependant on biocriteria. We are surprised that the macroinvertebrate criteria is taking this long...we are far, far behind other states in this regard. Perhaps this could be handled in a re-prioritization of funds.

Response: The goals and objectives in this draft are just a skeleton and will change as we get input from reviewers and as the workgroup starts meeting. We would appreciate your input at these meetings. This comment has showed up more than once and will definitely be addressed by the workgroup.

P1, A Objective, Strategies: Several problems here. Your objective measures suggest invertebrate monitoring by DNR and volunteer groups, yet invertebrates are not listed in the list of strategies. Fish are mentioned 4 times. To my knowledge DNR is working with invertebrates for biomonitoring, yet has not started with fish. The Department of Conservation, Department of Health, and other agencies are working with these elements of the fish community. The status of goals of invertebrate and fish biomonitoring need to be clarified because there are large differences in terms of status and organizational progress in this area.

Response: Same as above. Your participation in the workgroup would be appreciated.

P4, C Objective: These could be more quantitative (see University Extension section). For example, objective measure #1 could be changed to “Increase number of workshops by 10% per year to insure that 50% of teachers and youth leaders have had training by the Year 2003”.

Response: This issue will be discussed further in workgroup meetings.

P6, para 1: Shouldn’t this say “lots of at least three acres are exempt from construction standards...unless required by ordinances developed at the county level.”?

Response: We do not have the authority to make edits to the strategic plans of other agencies. Your comment was directed at the Missouri Department of Health’s strategic plan which is presented verbatim. I would encourage you to contact Daryl Roberts at (573) 751-6400 if you would like to address this issue with the MDOH.

P9-26: This section, developed by the University Extension, is much clearer in terms of objectives, strategies, implementation plans, and measures of success compared to the first section concerning DNR programs. It would greatly improve the document if the DNR section and those of other agencies were organized similarly.

Response: We can’t change the other agencies’ plans but the DNR section could be modified. This can be discussed in the workgroup.

P11, last 2 lines: This should say “e.g.” to indicate that this is only one example or else expanded. There are many other ways to evaluate the effectiveness of community water supply programs.

Response: This comment refers to the strategic plan of University Extension which we cannot change. They will be revising their plan this winter. If you would like to participate or address the issues you have raised you may contact Bob Broz, Water Quality Program Director, at (573) 882-0085.

P23, para 2: Items in parenthesis appear to be editorial comments not totally resolved. Please change. Similar notes for page 25 under solid waste.

Response: Same as above.

P27 to 31: The Missouri Department of Agriculture component should be deleted as it does not really address the benefits of non-point source pollution prevention. Rather, it is delivered in a verbal format that detracts from the overall goals of this document. Neither Strategic Issue I nor II addresses NPS pollution. Strategic Issue III appears as a book-keeping exercise only directed at minimal efforts. Strategic Issue IV is delivered in a confrontational manner that indicates that environmental protection is an impediment as opposed to a goal (e.g. Goal 2 should read: “Resolve agricultural issues as they impact the environment. Strategic Issue V

(incorrectly listed as I) implies that bad science has led to a mis-perception of environmental impacts of agriculture.”

Response: The NPSMP is a plan for the state and should include the NPS related goals/objectives of all the partners. In the partners’ plans, a reference is given in parentheses to the overall NPS plan. This is to indicate where their objectives/strategies overlap or enhance the plan. The Department of Agriculture’s newest strategic plan, which will be included in the next draft of the NPSMP, is more in line/has more overlap with the NPSMP.

Under Goals for NPSMP, page 14, A. Water Degradation by Animal/Poultry Waste, Objectives: Add:

- 3. Evaluate and implement alternative uses of animal waste*
- 4. Evaluate application rates and assimilation capacities to reduce nutrient runoff and aquatic impacts.*

Response: Your comment addresses the strategic plan of University Extension. All of the excerpts of plans of other agencies in the NPSMP are typed verbatim. We do not have the authority to modify their plan. University Extension will be updating their plan this winter. If you would like to participate and/or address the comments you made, please contact Bob Broz, Water Quality Program Director, (573) 882-0085.

Under B. Water degradation by Mineral Elements (Plant Nutrients) on page 15 of the Goals for NPSMP, isn’t a 10% reduction in fertilizer use minimal since half or more of nutrients may move off the site with runoff? Why not 25% or greater reduction as a goal?

Response: Same as above.

Under Goals for NPSMP, page 30, Add: “Objective A11: Work with the University of Missouri and other entities to conduct research on reducing pesticide, herbicide, and fungicide runoff.”

Response: Your comment addresses the strategic plan of the Missouri Department of Agriculture which we do not have the authority to change. They have just revised their plan and it will be incorporated into the next draft of the NPSMP. I would encourage you to contact Sarah Tyree of DOA at (573) 751-2477 if you would like to address the issues you raised.

In-text #4: Goals for NPSMP, p. 13, Theme 3: Nutrients & Bacterial Wastes, para. 2, line 3: “The Missouri approach to..., has been successful.” The validity of this statement is questionable.

Response: This information is taken from University Extension’s strategic plan. I would encourage you to contact Bob Broz (see earlier response) to address this issue.

Under the Educational Opportunities objective, we think you should add a strategy, or expand an existing strategy, to cover sponsorship or support of permanent environmental education displays, such as the one being constructed at the Springfield Discovery Center.

Response: This comment will be considered by the NPSMP workgroup which will begin meeting in the near future.

Page 2 - line 10 “..albeit with a very low quality of information..” Does “low quality” mean small amount or poor quality data?

On page 2, the reference to “a very low quality of information” could be phrased more positively; we may need to rely on this information in legal proceedings so it would be best not to denigrate it in the plan. I suggest the following phrase: “albeit better information would improve the assessment” or words to that effect.

Response: This statement will be revised in the next draft. Low quality means that the type of data collected and the amount collected at this point is probably not sufficient for assessing the state’s waters for NPS impairments.

Page 11, Item B, Objectives: -Replace “By 2000, convince 15...districts to develop..” with “By 2000, 15...districts will develop...”

Response: This comment addresses University Extension’s strategic plan which we do not have the authority to modify. They will be modifying their plan this winter. I would encourage you to contact Bob Broz, Water Quality Program Director, at (573) 882-0085 if you would like to participate in that process.

Theme 3: Nutrients and Bacterial Wastes, B. Water Degradation by Mineral Elements (Plant Nutrients). Comment regarding Lincoln University’s plant nutrition program.

Response: Thank you for the information regarding your program. Your program’s input during the workgroup meetings would be appreciated. This comment addresses University Extension’s strategic plan which is typed verbatim. I would again encourage you to contact Bob Broz and discuss your comments with him further.

Theme 4: Surface/Groundwater and Watershed Protection. Comment regarding Lincoln University’s plant nutrition program.

Response: Same as above.

How will we achieve the NPS goal of reducing by 25% the waters not fully attaining all beneficial uses due to NPS by 2008 if our watershed identification will not be done until 2008 (p.1)?

Response: The goals and objectives in this first draft are just a skeleton and will change as we receive feedback and as the workgroup convenes. Several other reviewers have had the same comment regarding this goal. The workgroup will certainly address this issue and would appreciate your input.

On page 6, with respect to on-site sewage disposal, the phrase, “but there is no authority for assuring systems are maintained” should be amended to read “but there are significant practical and legal obstacles to maintaining systems.” In a particular case, we may want to argue implicit legal authority to enforce system standards despite the lack of express statutory authority. The proposed change keeps that door open.

Response: This comment is directed at the Department of Health’s strategic plan which we do not have the authority to change. All of the plans in the NPSMP from other agencies are typed verbatim. I would encourage you to contact Daryl Roberts from MDOH at (573) 751-6400 if you would like to discuss this issue further.

On page 12, the phrase “Hazardous (Toxic) Material” is used with respect to pesticides. This phrase is not known in the law. Missouri law recognizes “hazardous substances”, which definition could include pesticides. See section 260.565, RSMo 1994. The Federal Toxic Substances Control Act regulates “chemical substances,” which does not include pesticides. See 15 U.S.C. section 2602(2). I suggest using the term “hazardous substances” or “pesticides.”

Response: This comment addresses the University Extension’s strategic plan which we do not have the authority to modify. They will be modifying their strategic plan this winter and if you would like to participate or bring your comments to their attention please contact Bob Broz, Water Quality Program Director, at (573) 882-0085.

On pages 23-24, the plan discusses biological resources with only a fleeting reference to chip mills. Innovative legal strategies may be required to stem this potential threat to water quality. The objectives and implementation plan should include legislative initiatives to provide incentives and regulation of chip mills as well as to encourage cooperative and creative legal problem solving using available enforcement tools.

Response: Same as above.

On pages 25-26, the plan discusses compostable waste disposal. The objectives and implementation section should recognize and foster the leadership role of Northwest Missouri State University’s biomass energy program. More research and demonstration by Northwest will help create markets and data to support solids separation, composting and renewable energy. In turn, water quality will benefit.

Response: Same as above.

The excerpt on page 27, Increased Production of Livestock, seems out of place and should be deleted.

Response: The Missouri Department of Agriculture has submitted a more recent edition of their strategic plan which will be incorporated into the next draft of the NPSMP. This plan is more in line with the goals and objectives of the NPSMP. This issue will be discussed further in the workgroup meetings.

On page 29, dead animal disposal must be in compliance with Chapter 644 as well as Chapter 269, RSMo. The department should take advantage of this opportunity to clarify this jurisdictional overlap with the Department of Agriculture, possibly through the workgroup.

Response: We can't change their plan but we can discuss this issue in the workgroup.

The objectives regarding pesticides on pages 30-31 may conflict with the more ambitious objectives expressed earlier in the plan. Perhaps this is another area for discussion by the workgroup.

Response: Same as above.

On page 41, the plan refers to "several significant animal waste spill" occurring "[r]ecently." In fact, the most significant animal wastewater spills occurred a few years ago. In addition, process water, not animal waste, was spilled in those instances. The animal agriculture lobby will raise these points, so perhaps we should clarify them now. I suggest qualifying the sentence by referring to "relatively recent" spills of "animal wastewater", "lagoon water" or "animal waste and lagoon water" for example.

Response: This issue is directed at the USDA - Natural Resources Conservation Service's strategic plan. We do not have the authority to change it. The contact for the Natural Resources Conservation Service is Bob Ball, (573) 876-0900. Please contact him if you would like to address this issue further.

Under UNIVERSITY EXTENSION, while they are the education agency it seems that partnering, and coordination of agencies might be improved. Under implementation, interacting with DNR, MDOH, NRCS, and SWCD boards is mentioned.

Under Theme 1: Drinking Water Supply, A. Private Water Supply, p.9, an objective to instruct prospective new well owners on state water well standards is discussed without mention that DGLS has current regulatory authority under RSMo. 256.600-256.640, and offers guidance to individuals and requires certification of any driller/installer working in Missouri. It further states 75 percent will employ certified drillers, without indicating what the current percentage is?

Under Theme 1: Drinking Water Supply, C. Community Water Supply, p.11, the objective of providing assistance and information to communities with municipal water supplies is discussed, without any apparent reference to assistance available from the DNR, Public Drinking Water Program.

Under Theme 2: Hazardous (Toxic) Materials, p.12, the paragraph mixes agricultural pesticides and household pesticides. An estimate and source of agricultural usage is provided, while a generalized statement implies, without any reference that households of five million people have all forms of pesticides, and most likely will be irresponsible in their use and/or disposal of such products. This should be rewritten with some recognition to the ongoing programs encouraging responsible use and disposal of household hazardous waste. The DNR, Technical Assistance Program provides assistance in this area, as well as many communities that stage and conduct household hazardous waste collection points on specified days.

Under Theme 2: A. Water Degradation from Pesticides, item 3., p. 12, objective is to reduce use of row crop pesticides by 5 percent. Again this is a general statement that implies all pesticides must be harmful, and all of them contaminate waters of the state. Is there no information on fate and transport of various pesticides, as well as toxicity considerations? In other words, some pesticides are much more harmful to human health and environment than others. The Public would probably like to see an effort to reduce the more harmful pesticides, or at least some logical wording used here to state this, if it is indeed what our real goal/objective is.

Under Theme 4: B. Irrigation, Chemigation, Well Development, Implementation item 6., p. 18, develop training for those installing irrigation wells and emphasize proper well construction? The certified well installer should already be familiar with proper well construction and plugging methods, as per existing regulations.

Response: This comment has several parts to it that all refer to University Extension's strategic plan which we do not have the authority to modify. They will be revising their plan this winter and if you would like to participate or have your comments addressed by them you may call Bob Broz, Water Quality Program Director, at (573) 882-0085.

Under Missouri Department of Conservation, p.33, what is Goal II? Is the reader to assume since it says (Excerpts), that Goal II had nothing to do with the NPSMP?

Response: Yes.

Page 1 (Objective Measures) add a point number 9: Number of voluntary TMDL action plans implemented.

Response: I believe your addition is addressed in objective B of the plan. The goals/objectives/strategies will be changing over time as comments are received and changes are made during the workgroup meetings. Your input at these workgroup meetings would be appreciated.

NPS MANAGEMENT – MISSOURI’S APPROACH

Provide Tools.

It is important and I support the idea of “Safe Harbor” provisions discussed in this section.

Response: Thank you for your comments. Your input at the workgroup meetings would be appreciated.

The priority waters section of the report should clearly identify waters inhabited by federally listed species as priority waters. It would also be beneficial to include waters containing state listed Endangered species, as these species play an important role as indicators of water quality conditions and trends.

Response: Priority waters are identified through the development of the impaired waters list pursuant to section 303(d) of the federal Clean Water Act. The development of this list does not specifically take threatened or endangered species into account, although these species are subject to the same protections afforded others through the Missouri water quality standards. The impaired waters list is revised every two years and comments on how these species may be better addressed through that process are welcome.

Voluntary TMDL is an oxymoron, is it not? Maximum implies limit, and it is unlikely that local groups have the expertise, money, or desire to do such. Perhaps this should be “Voluntary Daily Loading Goal” or some other term.

Response: These TMDLs are voluntary in the sense that a local watershed group can agree to accept certain limitations that will solve the water quality problem on the group’s terms, implementing its recommended methods on a mutually agreeable schedule. The limitations are binding and regulatory action may be taken if the solution is not implemented.

NONPOINT SOURCE CATEGORIES

AGRICULTURE

Animal Production

P1, para 3: There are more than 3 major areas and these are not necessarily the greatest concerns. As listed in the next paragraph, ammonia toxicity is a major problem that is not necessarily captured under the area of eutrophication or nutrient enrichment. Likewise, I’m not sure that “pathogens” has been proven to be an environmental impact on the level of riparian habitat modification, instream habitat modification, or ammonia toxicity. Similarly, one could argue that “riparian habitat disruption” is not related to “pastured animals” but rather “improperly pastured animals”... this is not a trivial distinction. The first section on the next page makes this point quite nicely.

Response: A separate discussion on ammonia has been added. “Improperly pastured animals” was not added as there is no agreed to criteria on pastures.

Nutrients/eutrophication (page 1) - - This section should be combined with the corresponding “Nutrients” section under crop production and cross referenced.

Response: This was not done so as to maintain a discussion in each section.

URBAN STORMWATER RUNOFF

First paragraph. I agree that sediment is the primary contaminant. Can it be stated that chemical and nutrient uses in urban areas also pose a threat to water quality.

Response: The first paragraph of this section, as well as the entire urban discussion, does refer to all types of pollution being present in urban stormwater. Therefore, we do not see the need to change this paragraph.

P.7, 3rd paragraph under Pesticides, Atmospheric deposition of pesticides in research that I am aware of is not known to be any problem to urban or rural watersheds by any research. Detection of pesticides in some studies can be in low parts per trillion but not of consequence and never linked to any stormwater concerns. The paragraph should be taken out.

Response: We have information that agricultural pesticides have been found in urban environments; therefore, we will leave this paragraph as is.

Urban storm water regulations, p. 2, USEPA is expanding the definitions of areas that come under regulation. What additional criteria or detail can be added to provide some explanation of the possible changes? What size of community, or other information?

Response: Since Phase II of the stormwater regulations is still in the process of ongoing negotiation, we decided it would be best to provide less information about the future of urban regulation, since anything in this document may change in the next year and lead to misleading or inaccurate statements. Therefore, that paragraph will be reworded to read:

At this time, under Phase II of the stormwater rule, the USEPA may expand the definition of areas that come under regulation.

RESOURCE EXTRACTION

Under RESOURCE EXTRACTION, Water Quality Problems, the 128 miles affected by abandoned lead-zinc mines seems very conservative. Should a more accurate number be desired, please coordinate with the Hazardous Waste Program, Superfund Section.

Under RESOURCE EXTRACTION, Figure IV-2, Best Management Practices under Smelter Areas, we would suggest adding the separation of precipitation from process water, and contaminated water, thereby minimizing the commingled water that requires collection, storage, and treatment. Use of gutters and enclosures at some of the buildings, as well as reduced dumping of the ore in outside areas, would have possible application.

Response: Your suggestion has been implemented by adding the separation of precipitation from process water as a *Best Management Practice* under the *Smelter Areas* portion of Table 7 (formerly called Figure IV-2).

Under Resource Extraction/Sand and Gravel, Federal and State Authorities: The decision in American Mining Congress v. United States Army Corps of Engineers, No. 93-1754 SSH nullifies the joint EPA/COE rule regarding the definition of “incidental fallback” and removes much of the Corp’s authority regulating dredging (see attachment).

Response: The *Resource Extraction/Sand and Gravel, Federal and State Authorities* section has been revised to discuss the regulatory roles of the Corps of Engineers and the Land Reclamation Program in light of the recent legal decision.

On Resource Extraction section: This section does not contain sections on subsurface mining or mine and mill tailings. Recently, the Missouri Chapter of the American Fisheries Society developed and approved a position statement on mining which includes these categories. A copy is enclosed. Some of the information concerning resource values, types of impacts, and state statistics on impacts are included.

Response: The *Resource Extraction* section addresses both surface and underground mining activities. The *Resource Extraction /Control Program and Concerns* subsection has been revised to discuss the regulatory controls on mill tailings piles provided by the Metallic Minerals Waste Management Act.

On Resource Extraction section Figure IV-1: Doesn’t the Corps of Engineers regulate sand and gravel extraction in large rivers of interstate commerce? This is not reflected in Figure IV-1.

Response: The Corps of Engineers does regulate sand and gravel extraction in large rivers of interstate commerce under Section 404 of the Clean Water Act. Figure IV-1 (renamed as Table 6) reflects the Corps regulatory authority over sand and gravel extraction under the activity of regulating the discharge of dredge and fill material to the waters of the United States, including wetlands.

WATERSHED IMPLEMENTATION

MARK TWAIN WATERSHED PROJECT

What percent of the watershed is not adequately protected or exceeds acceptable erosion?

Response: USDA NRCS calculated that 54.3% of the watershed exceeds T.

Is the sediment being delivered to Mark Twain Lake exceeding the rate estimated for the reservoir design?

Response: Prior to the flood of 1993 sediment delivery was 25% of what was estimated. After 1993, shoreline erosion has caused increased lake turbidity due to loss of shoreline vegetative cover.

Is the sediment yield to the lake as predicted, but carrying more contaminants than expected?

Response: Contaminates levels are consistent with past years.

Is the project complete? Were Project goals met?

Response: Yes, the project is complete and some goals were marginally fulfilled while others exceeded what was agreed too. The overall project was considered to be a success.

FELLOWS-MCDANIEL LAKES WATERSHED

Under Watershed Implementation, Fellow/McDaniel Lakes Watershed, the project period is 1992 to 1997, and it states that this project is ongoing. To what extent have the goals and objectives been met?

Response: This section now includes a summary of the final report on this project.

JAMES RIVER/TABLEROCK LAKE WATERSHED PARTNERSHIP

Changed from:

Table Rock Lake was created in Southwest Missouri in the late 1950s. It is a popular recreational lake, drawing millions of visitors a year. The waters in this region have been historically known as high quality resources. Fishing for bass, crappie, and other game fish, boating, swimming, scuba diving, and other fresh water activities have been vital components to the area's economy. There have also been plans proposed recently to use Table Rock Lake as a drinking water source for the ever-growing community of Branson. The growth of the area is phenomenal and is continuing. Branson, although not in the James River Basin, relies on the quality of the area's lakes for its economic viability. Branson housed over 6,000,000 visitors in

1994. It is expected that this number will increase to over 10,000,000 by the year 2000. The James River is a major tributary to Table Rock Lake and has portions of the city of Springfield within its watershed.

To:

Table Rock Lake was created in Southwest Missouri in the late 1950s. It is a popular recreational lake, drawing millions of visitors a year. The waters in this region have been historically known as high quality resources. Fishing for bass, crappie, and other game fish, boating, swimming, scuba diving, and other fresh water activities have been vital components to the area's economy. The James River is a major tributary to Table Rock Lake and has portions of the City of Springfield within its watershed. Springfield withdraws drinking water from the James River in Greene County. The City of Branson recently completed a new drinking water treatment plant and intake on Lake Taneycomo just downstream of Table Rock Dam in close proximity to the intake that supplies drinking water to the College of the Ozarks. There have also been plans proposed recently to use Table Rock Lake directly as a drinking water source for the ever-growing community of Branson. The growth of the area is phenomenal and is continuing. Branson, although not in the James River Basin, relies on the quality of the area's lakes for its economic viability. Branson housed over 6,000,000 visitors in 1994. It is expected that this number will increase to over 10,000,000 by the year 2000.

Also, updated the project dates and amounts to reflect increases associated with this year's amendment.

SMITHVILLE LAKE WATERSHED PROJECT

In response to comments on the Smithville Lake Watershed project document, the paragraph describing populations served was edited as follows: (It is true that Kansas City does not receive water from the lake, but instead contributes water to Platte District #4, which also gets water from Smithville Lake. However, it was suggested that Kansas City would pull from Platte District #4 in the event of an emergency in the Kansas City water supply. Also, the 1998 inventory quoted by Hazardous Waste Program was not totally accurate. According to Kenny Duzan of the Public Drinking Water Program and Bill Hills in the Kansas City Regional Office, the lake serves more than just the three districts represented in the inventory.)

From:

Smithville Lake supplies drinking water for the cities of Smithville, Plattsburg, Edgerton, Trimble and four water districts with a total population served of 12,000. Kansas City occasionally pulls drinking water on an as-needed basis, also. The lake is heavily used for recreational purposes including camping, boating, fishing, skiing and swimming.

To:

Smithville Lake supplies drinking water for the cities of Smithville, Plattsburg, Edgerton, Trimble, Tracy and seven water districts serving over 15,000 residents. The lake is heavily used for recreational purposes including camping, boating, fishing, skiing and swimming.

TURKEY CREEK WATERSHED PROTECTION PROJECT

The second paragraph mentions objectives, one of which is to treat 75 percent of CRP ground released with no-till farming. Are we paying the landowner to no-till ground that we paid him for ten years to not farm?

Response: Sentence was revised. 319 funds are not being used as incentives for no-till.

On the map showing Special Area Land Treatment (SALT) and Earth Watershed Projects, Turkey Creek in Carroll County and Ray County is shown. Why is there duplicate efforts being funded by both Soil and Water Conservation Program tax money for a SALT project and 319 funding as shown in the Watershed Implementation section mentioned above?

Response: We have either SALT or EARTH projects in many of our 319 grant-funded watersheds. The 319 dollars currently require a 40% nonfederal match, and the S&WCP tax dollars fulfill this federal requirement.

The Table listing the SALT projects shows, unlike the map, that Turkey Creek project is in Ozark County. What is the correct location of the Turkey Creek SALT project?

Response: It's true, there is more than one Turkey Creek in Missouri and several have SALT projects. The 319 project is in Carroll and Ray counties.

AgNPS SALT PILOTS AND SALT WATERSHEDS

The Table listing the SALT projects indicates that the Clarence Watershed project emphasized preventing erosion, as the lakes were a threatened drinking water supply. As per the Inventory of Missouri Public Water Systems, 1998, Clarence now buys its water from Macon PWSD number 1.

Response: Your statement is correct and this information will be changed in the rulemaking proposal which should go through in 1999.

IMPLEMENTATION ASSISTANCE

Brief summaries of the 12 AgNPS SALT were added to the document as suggested (see revised draft, Watershed Implementation, Overview of SALT Pilots). Summaries for Concordia, Higginsville, Monroe City and the James River Partnership were not readily available and were not included. In speaking with Bob Ball, these summaries will be available on the MoWIN webpage in the near future.

WATERBODIES WITH PROBLEMS NOT QUITE SEVERE ENOUGH TO BE ON THE 303(d) LIST

The MCL of atrazine has over a 5000 fold safety factor within it. There is not a need for a list utilizing a de factor standard that is set arbitrary. This list does not match the 303(d) nor the additional monitoring list.

Response: 1) With respect to specific standards, the Missouri Water Quality Standards includes a value of 3 µg/l for atrazine in waters protected for drinking water supply. The NPSMP would not purport to unilaterally alter a state standard established through the formal rulemaking process.

2) The management plan addresses more public water supply reservoirs than are on Missouri's proposed 1998 303(d) list because the plan also addresses waters at risk of exceeding water quality standards.

3) This management plan is being produced concurrently with the development of the 1998 303(d) list. The final list will be incorporated into the NPS plan.

PUBLIC REVIEW DISTRIBUTION LIST

- * American Fisheries Society
- Conservation Federation of MO
- * DNR-Air Pollution Control Program
- * DNR-Division of Energy
- * DNR-Division of Environmental Quality
- * DNR-Division of Geology and Land Survey
- * DNR-Environmental Services Program
- * DNR-Hazardous Waste Program
- * DNR-Jefferson City Regional Office
- DNR-Kansas City Regional Office
- * DNR-Land Reclamation Program
- * DNR-Northeast Regional Office
- * DNR-Public Drinking Water Program
- * DNR-Soil and Water Conservation Program
- * DNR-Solid Waste Management Program
- DNR-Southeast Regional Office
- * DNR-Southwest Regional Office
- DNR-St. Louis Regional Office
- DNR-Technical Assistance Program
- * DNR-Water Pollution Control Program
- * Esther Myers
- * JD Information Services
- Kansas City Water Services Dept.
- Lincoln University Extension
- * Mark Twain National Forest
- * Metropolitan St. Louis Sewer District
- Mid-America Dairymen Inc.
- * MO Ag Industries Council, Inc.
- * MO Attorney General's Office
- MO Chamber of Commerce
- * MO Corn Growers Association
- * MO Dairy Association
- * MO Department of Agriculture
- * MO Department of Conservation
- * MO Department of Health

- * MO Farm Bureau Federation
- * MO Pork Producers Association
- MO River Communities Network
- * MO Soybean Programs
- Monsanto Co- Q2F
- * Newman, Comley, Ruth
- National Park Service
- * Novartis Crop Protection
- * REGFORM
- Show-Me Clean Streams
- Springfield City Utilities
- * UMC Outreach and Extension
- USDA-Farm Service Agency
- * USDA-Natural Resources Conservation Service
- * US EPA Region VII
- * US Fish and Wildlife Service
- * US Forest Service
- * US Geological Survey

*Agencies/organizations that participated in review and/or workgroup meetings.

PUBLIC COMMENTS AND RESPONSES

Comments received during the first public review period (Feb. – Mar. 1999):

NPSMP GOALS AND OBJECTIVES:

The statement of Goals, Objectives and Measures of Success in the draft plan is weak and incomplete, and the Milestones section is not yet written. The lack of detailed goals and timetables means that this is not yet a management plan. It would be difficult to generate teamwork with all the other parties expected to participate in NPS management without a strong framework and set of timetables. The cooperation, coordination, and voluntary local effort called for in the Objectives all require a design for action that is not yet in place. The management plan should not be accepted until this failing is remedied.

Response: The NPS workgroup met several times after the first draft was released for public review in February 1999. The second draft for public review contains more explicit goals and objectives that reflect comments received and the input of the workgroup. The objectives list a time frame by which they are to be completed but the milestone schedule is not complete at this time (second review period, May 1999). The milestones are the objectives with more detail added regarding lead agencies. The workgroup will continue to work on the milestones during the second public review period and the final draft submitted to the Clean Water Commission will contain a complete milestone schedule.

Timing and resource availability are essential factors in achieving established goals. Our review of the “Goals for NPSMP” suggests that more time should have been allotted by some partners to attain the stated goals. Some of the activities scheduled to be completed by the year 2000, for example, will probably take longer. It is also unclear whether an assessment of available resources (people and money) has been made to support activities related to goal attainment.

Response: The strategic plans of other agencies are not within DNR’s purview so I cannot respond to your statement regarding time allotted or resource assessment in order to attain goals. DNR’s strategic plan was based on our best available assessment of resources we currently have and may have in the future.

We are uncertain as to whether adequate effort has been put forth to develop plausible solutions to identified problems or plan implementation strategies for goal achievement taking into consideration available resources. For example, the strategies listed by DNR for achieving the objective of a “complete statewide aquatic macroinvertebrate monitoring and statewide habitat assessment” do not identify what type of “research” is needed, the extent of “fish tissue sampling”, how to “initiate monitoring on the Missouri and Mississippi Rivers” or how “special studies of habitat, fish communities” will be conducted. The “identification of watersheds which are most affected by

nonpoint source pollution” seems to be a paramount objective of a state nonpoint source management plan and one which should be given the highest priority. Sufficient resources may or may not be available to realize this objective in a timely manner. What resources are needed apparently has not been addressed in the Plan. As we all know, we must adequately define the problem and its causes before we can develop an acceptable solution and determine its cost. Does or will DNR have sufficient resources to meet this objective, is a valid question particularly since a nonpoint source management plan has been in effect since 1989 and this question (or objective) has not been completely answered.

Similar comments can be made with regard to other “partners” contributing to the development of what is hoped to be a viable and cost effective NPSMP for our state. Most all partners have stated admirable goals and objectives. They all know what they want to do or would like to do but exactly how to do it with available resources, in our opinion, has not been adequately addressed.

Response: The plan is not a detailed blueprint for nonpoint source management. Rather, it serves as a framework or compass leading us in the direction we want to head to address the problem. This framework has been supported and written by the partners who will be actively involved in implementing the plan. The details of how to implement strategies will be determined by the individual partners (lead agencies) in cooperation with other partners to ensure objectives are achieved.

It might make sense for the DNR to develop a relatively efficient process for bringing stakeholders together to discuss the various sources that may impact a given watershed and the various best management practices that may be helpful to reduce the extent to which nonpoint sources within the watershed are impacting the water quality. It might be helpful if the NPSMP included a description of a “generic” problem-solving process or decision making process for use by stakeholders within a given watershed so that each watershed doesn’t have to “recreate the wheel.” The “generic” problem-solving process or decision making process also could identify the extent to which the various state or federal governmental agencies would have information, human resources, or financial resources that could be accessed to support development of a voluntary water quality management plan for a watershed.

Response: DNR supports locally led and directed watershed initiatives and is very willing to provide information and support. In watersheds needing restoration where a watershed committee does not exist it may be necessary for DNR and other partners to help bring a group together. But a locally led, voluntary approach to watershed management is preferred. A “generic” problem-solving process that could be used by stakeholders is the development of a Watershed Restoration Action Strategy (WRAS). A WRAS is discussed in Section IV of the plan. A WRAS must be completed before Section 319 restoration money is awarded to grant recipients but it would be a good planning tool for any watershed group trying to determine strategies for restoration. DNR’s Nonpoint Source Program will have guidance available on the development of a WRAS in the near future.

FUNDING

It is embarrassing that Missouri's "Maintenance of Effort" is zero under the provisions of the Water Quality Act because that was our average in 1986 and 1987. Couldn't we set a goal in this NPS plan that our funding should be maintained at or above the level requested by Governor Carnahan this year--\$639,000? The program will need skilled staff to carry out the technical and interactive elements of the plan, and these require funds.

Response: Goal C, Objective 5 has been added and states: Maintain funding of NPS activities at or above 1999 levels.

NPS CATEGORIES

URBAN/SUBURBAN STORMWATER RUNOFF

Considering the Phase II impacts on our area of jurisdiction which will require NPDES permitting of stormwater discharges from storm sewers, some correlating mechanism in the NPSMP should be included to prevent duplicate control efforts. We believe the greatest pollution load to natural watercourses in our area from storm runoff enters through identifiable pipes, conduits or channels. A proper application of Phase II BMPs coupled with municipal cooperation within defined watersheds would do much to protect water quality in our area. The section of your NPSMP entitled "Urban/Suburban Stormwater Runoff" should address this relationship.

Response:

Comments received during the second public review period (May – June 1999):

NPSMP GOALS AND OBJECTIVES:

Goal A, Implementation strategy – Pursue a DNR budget expansion of 23 FTEs solely for water quality monitoring and water quality data management. Taken at face value, this seems to be an excessive number of new employees for this purpose.

Response: This was included to indicate the level of effort at least one partner is taking to help meet water quality goals. This measure has already been approved by the legislature so it will be removed from the strategies.

Goal B, Implementation strategy – Target support to Unified Watershed Assessment Category I watersheds for voluntary TMDL action plans or WQMP plan implementation. The Clean Water Action Plan stipulates that support will be targeted to priority watersheds identified by the Unified Watershed Assessment (UWA) and

other assessments. However, as stated in comments submitted during the public comment period, we have serious reservations concerning the UWA. Its utility for setting priorities is limited by virtue of the fact that 56 of Missouri's 66 watersheds are in Category I. Also EPA's unrealistic deadlines resulted in a rushed assessment based on inadequate data.

Response: This strategy was reworded to say: "Revise the UWA to make more usable and then target support..."

Goal B, Implementation strategy – Encourage the adoption of urban and suburban stream protection and stormwater sediment control resolutions and ordinances. Voluntary rather than regulatory measures should be encouraged.

Response: This strategy was reworded to say: "Advise local entities on the appropriate use of urban and suburban stream protection..."

Goal B, Evaluation measure – On a project-specific basis: tons of soil saved, nutrient applications reduced or prevented from leaving the field, reductions in pesticides applied, reductions in pesticides leaving the field. Reduced nutrient and pesticide applications may achieve reductions in losses from the field, but they should not be evaluation measures in and of themselves. Reduced application is only one alternative for managing nutrients and pesticides in runoff.

Response: The evaluation measure has been reworded to say: "On a project-specific bases, quantifiable measures such as: tons of soil saved, nutrients and pesticides prevented from leaving the field, reductions in nutrients and pesticides applied if appropriate."

Goal B, Evaluation measure – Number of Comprehensive Nutrient Management Plans (CNMP) implemented at animal feeding operations (AFOs). And Goal B, evaluation measure – Number of acres on which animal waste is applied in accordance with an approved CNMP. It seems premature to make CNMPs an evaluation measure. It is my understanding that CNMPs that meet the specifications set forth in the Unified National AFO strategy will not be available via public or private sources for at least one year and likely two or more. Moreover, proposed federal funding to provide technical assistance for CNMPs does not even come close to meeting cost projections for the program. I would suggest the number of acres under voluntary nutrient management plans as an alternative. If the number of CNMPs is included as an evaluation measure, then the number of acres on which waste is applied in accordance with an approved CNMP seems redundant because implementation of a CNMP infers application as prescribed by the plan.

Response: Evaluation measure was reworded to reflect "voluntary nutrient management plans" rather than CNMPs.

Goal B, Evaluation measure – Number of Stream Teams and volunteer monitoring teams. The number of stream teams and volunteer monitoring teams should not be an evaluation measure. The number of these teams does not correlate to nonpoint source impacts on water quality except perhaps in localized situations. Moreover, using volunteer programs as an evaluation measure raise the stakes for adding teams irrespective of the department’s need for reliable monitored data collected by trained professionals.

Response: This evaluation measure is related to Goal B, Objective 3 and is one of many measures of information and education activities.

Goal C, Implementation strategy – Work with local authorities to achieve goals in the state NPSMP. Recommend adding “and landowners” after “local authorities.”

Response: The additional language was added.

Pursuant to our discussion, please omit the Missouri Farm Bureau policy resolutions from Section IV. As I indicated to you, Betty Keehart had expressed interest in these resolutions, but it does not seem appropriate to me to include Missouri Farm Bureau with the six public entities identified in this section as “partner agencies.” Also, some of these policy resolutions are not current because they were amended by voting delegates at our annual meeting last December, a process which occurs annually.

Response: As indicated on the Public Review/Distribution List, many entities, both public and private, have been actively involved in the development of this plan. Likewise, many entities, both public and private, will be involved in its implementation. The section referred to includes excerpts of strategic plans from only a portion of those entities. Unfortunately, this section reflects primarily the public agencies because those are the documents made available to us. We appreciate the involvement of Farm Bureau and the others in this process and look forward to working with them during implementation of the Plan. Farm Bureau’s policy resolutions have been removed from the plan as requested.

GENERAL COMMENTS

Based on a quick review of the NPSMP, it is not clear if the DNR must devise management systems for all pollutants/sources (they are certainly all accounted for in the NPSMP) or if the DNR can selectively address the pollutants/sources associated with the most impairment. It is clear from the State Fact Sheet (1996) that point sources and nonpoint sources are contributing to the impairment of Missouri lakes, rivers, streams, and groundwater.

Response: The department, together with its partner agencies and groups, accepts as its mission to address all of the water quality issues in Missouri. To the extent that many problems stem from nonpoint sources, they will be addressed through the development and implementation of this plan. Where point sources are also involved the department

will address both types of sources to establish an equitable distribution of the work needed to reduce the pollutant load or otherwise eliminate pollution.

The NPSMP is intended to improve or restore water quality for the benefit of human health and the environment. But it is not clear how the DNR will address resources that can not be used for drinking water, swimming, or as a natural habitat due to natural causes. A river, stream, lake or groundwater that is “naturally” unusable (due to the natural existence of high salinity, high temp, natural chemical content, etc.) should not be considered “impaired.” In this case, the DNR should not target the resource for “improvement.”

Response: Some water resources are not usable for some purposes in their natural states. In general, neither the plan nor the department would strive to improve on nature. In some cases waters are recognized for failing to meet standards and are listed as impaired, although there may not be any remedy available for the situation other than a recognition that it exists. Examples include manganese released from sediments in lakes and low dissolved oxygen in slow flowing prairie streams during hot weather. In many of these cases the water quality standards, the yardsticks used to measure water quality, may be appropriately changed to address reasonable expectations for waters that do not otherwise rise to the levels that support typical uses, through no human cause.

The DNR reports that 100% of the lakes in Missouri have been surveyed. Of all pollutants listed in the “1996 State Fact Sheet,” oxygen depleting substances and pesticides account for more than 98% of all pollutants known to cause impairment. Of all known sources, the agricultural industry and other natural influences contribute 93% of this pollution. Over 50% is contributed by the agricultural industry alone.

It is tempting to target this industry for further regulation, however, the oxygen depleting substances and pesticide levels may be due to seasonal weather patterns rather than the poor application of chemicals. Heavy rainfall in the spring can fill lakes with cropland runoff. Lakes with low turnover rates have little opportunity to recover quickly. Rivers and streams that can recover quickly have low levels of oxygen depleting substances and pesticides.

Response: With regard to oxygen depleting conditions, most Missouri lakes that suffer from this form of pollution do so because of materials that decompose, thus consuming oxygen, which are primarily introduced by human activity. Pesticides of concern in lakes are almost all synthetic compounds that are managed for crop production. While the management of lakes can take into account seasonal variations, turnover and other physical attributes and changes in the lake environment, it is clear that all of the materials can be managed in an environmentally protective manner, and the incidence of pollution is an indicator that that management can be improved.

The DNR reports that 41% of the rivers and streams in Missouri have been surveyed. Of all pollutants listed in the “1996 State Fact Sheet,” Habitat Alterations and Siltation account for more than 97% of all pollutants known to cause impairment. Of all known

sources, the agricultural industry, hydro-modification, channelization, and other natural influences contribute over 98% of this pollution.

Channelization by its operation, can also cause hydro-modification and the natural influences that are listed as sources. Because of this, channelization is probably the cause of over 60% of impairment in Missouri rivers and streams. It is not clear how the DNR can reverse the affects of channelization.

Response: Channelization is addressed either actively or passively. The best example of active intervention is the restoration of the Kissimmee River in Florida, in which cut off channels are being rehabilitated to carry flow once again, adjacent wetlands are restored to vigorous conditions, and the old constructed channels are isolated and abandoned. Passive restoration, which obviously takes more time, allows the stream or river to use its energy to re-establish a typical channel, provided that flow regimes and buffer areas are provided.

Assuming that “big river” data is not dominating the results found in the “1996 State Fact Sheet,” the greatest benefit to Missouri lakes, rivers, streams, and groundwater could come from the continued study of these systems and their interactions with nonpoint sources. The study would help the planners of civil engineering projects and farmers decide how to lessen the negative impacts to Missouri’s natural resources. The fact sheet is clear that point sources are not contributing to the impairment of lakes, rivers, streams, and groundwater. Assuming that altering the affects of channelization in the short term is not practical and that pesticides and fertilizers are applied properly, the NPSMP should give the greatest amount of attention to the continued study and monitoring of aquatic biology and the monitoring of existing lakes, rivers, streams and groundwater.

Response: Monitoring will be emphasized in future work of the department, but not to the exclusion by any means of restoration work where that is possible.

APPENDIX C

Legal Certification

LEGAL CERTIFICATION

The WQA of 1987 requires:

“A certification by the attorney general of the State or States (or the chief attorney of any State water pollution control agency which has independent legal counsel) that the laws of the State or States, as the case may be, provide adequate authority to implement such management program or, if there is not adequate authority, a list of such additional authorities as will be necessary to implement such management program and a schedule and commitment by the State or States to seek such additional authorities as expeditiously as practicable.”

Preparation of the Nonpoint Source Assessment and Management Plan is the responsibility of the Department of Natural Resources as defined in Missouri’s Clean Water Law, RSMo 644:

644.021-1. There is hereby created a water contaminant control agency to be known as the “Clean Water Commission of the State of Missouri,” whose domicile for the purposes of sections 644.006 to 644.141 shall be deemed to be that of the department of natural resources...

644.136. The commission is hereby designated as the water pollution agency for the state for purposes of any federal water pollution control act and may

- (1) Take all necessary or appropriate action to obtain for the state the benefit of any federal act, or to obtain federal approval of any state water pollution control program;*
- (2) Apply for and receive federal funds made available under any federal act;*
- (3) Approve projects for which loans or grants under any federal act are made to any municipality or agency of the state;*
- (4) Participate through its authorized representatives in proceedings under any federal act;*
- (5) Recommend measures for reduction of water contamination originating within the state; and*
- (6) Recommend to the governor for his designation any areas of the state which require special action under sections 644.006 to 644.141 or any federal water pollution control act. The governor shall hereby be authorized, as provided in section 644.141 to so designate such areas and establish local agencies or authorities as required by any federal water pollution control act to carry out the planning and operation for such areas required by any federal water pollution control act.*

Text reproductions of the original letters.

MEMORANDUM

TO: Ed Knight
FROM: William Bryan
DATE: June 23, 1999
RE: *NPS Management Plan*

You have requested our certification that state law provides adequate legal authority for the Department to implement this plan as required by the WQA of 1987. Upon review of the draft plan, it is my opinion that state law provides adequate authority for the Department to implement the draft plan.

This certification does not extend beyond the precise question and answer articulated above. As you know, we are involved in litigation over the Commission's authority to entertain third-party permit appeals and we express no opinion as to how this ongoing litigation may affect the Department's authority to implement the plan, or if it will have any effect at all.

Please let me know if you have any questions.

WJB
c: Michael Warrick

APPENDIX D

Consistency Review

CONSISTENCY REVIEW

Section 319 of the Clean Water Act requires states to review federal assistance programs and development projects for consistency with their nonpoint source management programs (NPS). The Act requires each state to identify those federal programs and projects it will review for consistency and also requires the respective federal agencies to accommodate the identified concerns according to Executive Order 12372. This is not a new provision, as existing legislation requires federal agency compliance with all federal, state, interstate, and local pollution control requirements. The law directed federal agencies to modify their regulations within 60 days to allow state review of individual applications and also requires agencies to accommodate state concerns about consistency.

In August 1998 EPA proposed federal guidelines for implementation of Section 319 consistency provisions. This section may be amended to address requirements of the final rule. In addition, several court decisions have interpreted some decisions regarding implementation of section 401 of the Clean Water Act. Some of those lawsuits are currently under appeal and this section may be revised to be consistent with the final decisions in those cases.

Many of the procedures and mechanisms for ensuring consistency of federal programs with the state's NPS activities already exist at the state level. These include the State Clearinghouse administered by the Office of Administration (OA) and the National Environmental Policy Act (NEPA), which mandates the environmental assessment (EA)/environmental impact statement (EIS) process. The success of the review process will depend on the ability of the state and the federal agency involved to work cooperatively to resolve any conflicts. In addition to major federal actions, which are subject to these procedures, other federal permit and license procedures also include provisions through which consistency with the nonpoint source management plan may be accomplished.

To ensure early notification and effective communication to accomplish the consistency review process and achieve its clean water goals, the Missouri Department of Natural Resources (the department) will work with OA and through the NEPA process. Furthermore, the department will coordinate with the federal agencies that administer federal permit and licensing programs to ensure consistency. Additionally, development of Watershed Management Plans and Watershed Restoration Action Strategies in the state will provide an opportunity for addressing consistent nonpoint source remedial and funding activities on federal lands.

Specific federal assistance programs that will be reviewed by the state for plan consistencies include changes to USDA assistance programs including EQIP and conservation practice specifications, and the development of the USFS master plan. For USDA programs and practices, the nonpoint source staff will use their participation in the State Technical Committee to review and offer comments on changes as they are proposed and discussed. The Mark Twain National Forest is presently conducting

background work in anticipation of the major update of the forest plan in 2005, and this work includes water quality studies related to forest practices. These studies have involved the review of Department of Natural Resources staff. Furthermore, the department and other agencies are paying special attention to intensive forest harvesting practices that may be related to large chip mills that have begun operation in the state in the past several years. In addition to dealing with new programs or practices that emerge during the period of this plan, the nonpoint source staff may review existing program elements for consistency with this plan in a manner similar to the process described below for the review of federal land management practices.

The federal government owns and manages significant land areas within the state of Missouri. The state will work cooperatively with the federal agencies responsible for these lands to assure they are managed in compliance with the provisions of this plan. Below are items to be undertaken by the state (provided funds are available) to assure compliance on federal lands.

1. Provide a copy of this plan, as approved or revised, to the director of each agency managing federal lands in Missouri by the end of each fiscal year.
2. Develop (and maintain) a compliance checklist for review of federally managed lands by the end of 2000.
3. Visit with the land manager for each agency (or closer contact if appropriate) to review provisions of the program and the checklist during the period 2001 to 2004.
4. Cooperatively develop an action plan for any inconsistencies or noncompliance issues during the period 2001 to 2004.
5. Issue reports documenting these reviews and any actions taken, as each are completed.
6. Notify EPA of any unresolved issues following the above reviews, as identified.

Following is a listing of federal assistance and development projects, and permit or licensure activities that are subject to review for consistency with the nonpoint source management plan. Discussions of some of the programs administered by these agencies, and how their potential impacts may be managed through consistency review, follow the listing.

Department of Agriculture

Forest Service

- Forest Management Plans
- Timber Harvest Permits
- Grazing Permits
- Research Management Plans
- State and Private Management Plans
- Recreation Plans

Natural Resources Conservation Service

- Conservation Reserve Program
- Environmental Quality Incentives Program
- Wetland Reserve Program
- Conservation Compliance
- Farmland Protection Program
- Wildlife Habitat Incentives Program
- Emergency Watershed Protection Program
- Conservation Farm Option
- Resource Conservation and Development Program
- Forestry Incentives Program

Rural Development Agency

- Rural Housing Loans and Grants
- Home Ownership Loans
- Guaranteed Rural Housing Loans
- Home Repair Loans and Grants
- Rural Rental Housing Program
- Rural Housing Site Loans
- Self Help Technical Assistance Grants
- Farm Labor Housing Loans and Grants
- Housing Preservation Grant Program
- Business and Industry Guaranteed Loans and Direct Loans
- Commercial Facilities Direct Loans, Guaranteed Loans and Grants
- Fire and Rescue Loans
- Intermediary Relending Program
- Rural Business Enterprise Grants
- Rural Cooperative Development Grants
- Solid Waste Management Grants
- Technical Assistance and Training Grants
- Water and Waste Disposal Loans and Grants
- Rural Economic Development Loans and Grants

Department of the Interior

Bureau of Land Management

- Watershed Projects
- Mineral Exploration and Development
- Coal, Oil and Gas Leasing
- Coal Reclamation
- ORV Activities
- Timber Activities
- Grazing Allotment/Grazing Management/Permit Issuance
- Chemical Pesticides
- Area Analysis/Cumulative Impacts
- Wetlands protection
- Riparian Management Plans
- Hydrologic Modification
- Transportation Plans

- ACEC Plans
- Bureau of Reclamation
 - Irrigation Development
- Fish and Wildlife Service
 - Management of National Wildlife Refuges and proposed acquisitions
- National Park Service
 - National Park Management and proposed acquisitions
 - Wildlife Management
 - Grazing Management
 - Abandoned Mines Management
- Federal Energy Regulatory Commission
 - Dam relicensing
- Department of Defense
 - Natural Resource Management Plans and Projects
 - Military Construction Projects
 - Facilities Development Plans and Projects
 - Land and Water Based Military Training Plans and Exercises
 - Plans and Projects to Reduce Specific Nonpoint Source Problems
 - Projects under the Defense Environmental Restoration Program
 - Dams or Flood Control Works
 - Ice Management Practices
 - Land Acquisition for Spoil Disposal or Other Purposes
 - Selection of Open Water Disposal Sites
- Department of Transportation
 - Federal Highways Administration
 - Highway Construction/reconstruction
 - ISTEA
 - Federal Aviation Administration
 - Location, design, construction, maintenance and demolition of federal aids to air navigation
 - Airport and Tarmac Runoff

Department of Defense, U.S. Corps of Engineers

The U.S. Army Corps of Engineers is the federal government's largest water resources development agency. At the direction of Congress the Corps of Engineers becomes involved in varied missions including improving river navigation, reducing flood damage, and controlling beach erosion. The Corps also generates hydropower, supplies water to cities and industry, regulates development in navigable water, and manages a recreation program. Most of the surface waters in the U.S. are stored or moved through Corps of Engineers water control projects (dams, levee systems, and navigation projects). In total, nearly 2,000 water resources projects have been placed under the responsibility of the Corps of Engineers through authorities such as the Flood Control Act, The River and Harbor Act, and the Water Resources Development Act.

The Corps of Engineers authority to manage water quality is founded in the Federal Water Pollution Control Act of 1948 and its amendments, including the Clean Water Act

of 1977 and the Water Quality Act of 1987. Executive order 12088, Federal Compliance with Pollution Control Standards, also required compliance by Federal facilities and activities with applicable pollution control standards in the same manner as any non-Federal entity. To ensure project compliance, the Federal Facilities Compliance Act of 1990 provides for EPA and or states to inspect federally owned or federally operated facilities that are subject to the Clean Water Act of 1977.

For new projects, the regulations call for necessary studies and evaluations to be conducted during the engineering and design phase to ensure that the completed projects will be managed with clear objectives connected to water quality. These studies are to include watershed based evaluations of the “preproject” aquatic ecosystem, and evaluations of the physical, chemical, and biological factors that are likely to be influenced by the proposed project. These studies are also to include identification of watershed-based tools and practices that will achieve water quality standards and maintain the aquatic ecosystem in a sustainable manner once the proposed project is completed.

Department of Interior, Bureau of Reclamation

Missouri is within the Great Plains Region of the Bureau of Reclamation, headquartered in Billings, Montana with an area office in Grand Island, Nebraska. The USBR is involved in the management of water related resources west of the Mississippi River. Besides being the largest wholesale supplier of water in the United States, the USBR is the second largest hydroelectric power generator. The mission of the USBR is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. One of the ways this mission is accomplished is by encouraging all that receive Reclamation water to use it wisely at the outset. However, coordination among other associated agencies is also highly valued. The USBR Environmental and Planning Coordination Office serves as principal advisor to the Office of Policy for environmental compliance and resources planning under the National Environmental Policy Act (NEPA), Endangered Species Act, Fish and Wildlife Coordination Act, Clean Water Act, Clean Air Act, legislation related to hazardous waste, pest management and invasive species, Natural Resource Damage and Restoration, and related environmental legislation, rules, and regulations, as well as, the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies .

The USBR revised nearly all their environmental policy between 1994 and 2002. Areas of coordination and administration include: hazardous waste and materials management, floodplain management, dam operation, wetland mitigation, Cultural Resources; as well as activities under the Endangered Species Act and NEPA. The purpose of this effort is to build environmental values into the agency-wide operations of the Bureau of Reclamation.

Department of Interior, Bureau of Land Management

The Bureau of Land Management (BLM) administers its program for livestock grazing on the federal lands administered by BLM through the BLM Grazing Regulations. These

regulations authorize BLM to issue grazing permits for ten-year periods, provide guidance for the required development of state or regional standards and guidelines, and set forth criteria and management practices to achieve healthy rangelands. These standards and guidelines are to be applied through permits to ensure that the following fundamentals of rangeland health are achieved:

1. Watersheds are in, or making significant progress toward, properly functioning condition.
2. Ecological processes are maintained or there is significant progress toward their attainment.
3. Water quality complies with state water quality standards.
4. Habitats are, or are making significant progress toward being restored or maintained for threatened or endangered species.

In addition, the Bureau of Land Management also administers the extraction of mineral resources from federal lands.

Department of Transportation

Department of Transportation (DOT) Environmental Policy - DOT has developed a multi-level policy to include full involvement of partnerships, complete integration of environmental concerns, and active protection and enhancement of the environment. A key element of this policy addresses protection and enhancement of the environment and makes the commitment that the Federal Highway Administration will avoid, minimize and mitigate adverse effects of transportation projects on social and natural resources; implement innovative enhancement measures; participate in funding mitigation and enhancement activities; and ensure that transportation enhancement funding provided under ISTEA is used to maximize environmental benefits.

Federal Highway Administration (FHWA) Erosion and Sediment Control Policy - it is the policy of the FHWA that highways shall be located, designed, constructed and operated according to standards that will minimize erosion and sediment damage to the highway and adjacent properties and abate pollution of surface and ground water resources.

The Nonpoint Source Control Branch is in partnership with FHWA to develop and conduct an erosion and sediment control training course for State DOT offices and local governmental transportation officials and road crews.

Department of Agriculture

Farm Services Agency - FSA - Emergency Agricultural Conservation Program (ACP) -- The ACP program provides cost-share assistance to farmers for construction of a variety of soil and water conservation and agricultural pollution abatement practices. Practices can include pasture establishment, conservation tillage, winter cover-crop usage, terrace installation, fencing, surface drains, soil waterways, animal waste facilities, vegetative barriers and contour farming. Use of funds for practices that drain wetlands has been forbidden since the issuance of Executive Order 1190 in 1977.

NRCS - Farmland Protection Program
NRCS - Wetland Reserve Program
NRCS - Plant Materials Center (PMC) Program
NRCS - Grazing Incentive Program (GIP)

Rural Economic and Community Development - Watershed Protection and Flood Prevention Loans-- nonprofit, sponsoring local organizations in authorized watershed areas are eligible for cost sharing under this program. The project funds improvements such as flood prevention, irrigation, drainage, water quality management, sedimentation control, fish and wildlife development, public water based recreation, and water storage.

Rural Economic and Community Development - Resource Conservation and Development (RC&D) Loan Program -- Direct loans provided to public agencies and local nonprofit corporation in authorized RC&D areas for the purpose of developing community or public outdoor-oriented, water-based recreational facilities.

NRCS - Watershed Protection and Flood Prevention (Small Watershed Program: PL83-566 Program) -- This program provides technical and financial assistance for planning, designing and installing watershed improvement projects. Its purpose is to help protect, develop and utilize land and water resources in small watersheds. State agencies, counties (single or groups), municipalities, towns, Soil and Water Conservation Districts, flood prevention/control districts, or any other nonprofit organization authorized by State law to manage watershed projects are eligible for assistance. Emphasis is now placed on nonstructural protection practices.

NRCS -- Emergency Watershed Program -- The principal soil and water conservation technical assistance program of NRCS with assistance provided to plan a variety of soil and water conservation practices and structures, many of which are cost-shared under the FSA Agricultural Conservation Program.

NRCS Resource Conservation and Development -- program provides grants and advisory services for preparation and execution of long-range plans for flood prevention, sediment-erosion control, public water-based recreation, fish and wildlife developments, agricultural water management and control and abatement of agriculture pollution.

Department of Agriculture, Forest Service

The Mark Twain National Forest (MTNF) is 1,494,217 acres in size. The MTNF administers its programs for recreation, wilderness, wildlife, fisheries, timber, range, roads, minerals, fire, soil, water, and air. All natural resource management is guided by the MTNF Land and Resource Management Plan. Management direction includes goals, objectives, forest-wide standards and guidelines, management prescriptions with their specific standards and guidelines, and delineations of the management areas. Management direction is responsive to the requirements of the National Forest Management Act of 1976. The forest plan considers the environmental effects of forest management, including water quality impacts. The MTNF maintains standards and guidelines in the MTNF Forest Plan that pertains to water quality.

APPENDIX E

Nonpoint Source Categories

Agriculture
Silviculture
Construction
Urban/Suburban Stormwater Runoff
Resource Extraction
Stowage and Land Disposal of Wastes
Hydrologic/Habitat Modification
Other

AGRICULTURE

CROP PRODUCTION

Characterization

Crop production is particularly important to Missouri's economy. In 1992, from over 12 million acres of harvested cropland (Bureau of the Census, 1992) total production of principal crops was valued at \$2.5 billion (Missouri Farm Facts, 1994). <http://agebb.missouri.edu/mass/farmfact>

Acres devoted to production, in descending order, were: soybeans, 4.2 million; hay, 3.5 million; corn for grain, 2.4 million; wheat for grain, 1.3 million; sorghum for grain, 0.6 million; and cotton, 0.3 million (Bureau of the Census, 1992).

In 1997, acres devoted to production, in descending order were: soybeans, 4.7 million; hay, 3.7 million; corn for grain, 2.4 million; wheat for grain, 1.0 million; and sorghum for grain, 0.3 million (Bureau of Census, 1997). A large, but decreasing amount of this production is occurring on highly eroding croplands.

Commercial fertilizers were applied in Missouri to 9.7 million acres in 1992. Amounts applied are not readily available; the nearest approximation is 1.8 million tons shipped for use in Missouri (Missouri Fertilizer Tonnage Report, 1994). Insecticides were used on 1.8 million acres of crop and hayland; herbicides on 6.7 million (Bureau of the Census, 1994). Missouri ranked tenth in the nation in commercial fertilizer as an expense for farm production costs in 1997 with 3.6 percent of the U.S. total. <http://www.nass.usda.gov/census/census97/ranking/ac97s-3r.pdf>

In a survey conducted by the University of Missouri in 1992, producers of soybeans, corn, wheat and sorghum reported herbicides were applied to over 95 percent of all grain crop acreage except wheat, of which only 8 percent was treated. Herbicides accounted for 95 percent of the 13.4 million pounds of pesticide active ingredients applied (Becker et al., 1992).

(More recent production statistics are available for Missouri; however, the 1992 figures are useful for state to state comparisons of amounts of commodities produced and inputs used for production). The 1997 Bureau of Census survey can be read online at:

<http://www.nass.usda.gov/census/census97/volume1/mo-25/toc97.htm>

2001 Missouri Crop Summary

All Crop Summary Tables

Missouri farmers produced more soybeans, cotton, rice, potatoes, tobacco and hay in 2001 than a year earlier. Crops that declined in production from the previous year included corn, sorghum, winter wheat and oats. Wet weather occurred periodically during the spring planting season but farmers managed to plant most of the acreage intended for crops. Corn planting finished a few days ahead of average but single-crop soybean planting was extended into early July, slightly behind schedule. The above normal rainfall of May, June and July built some moisture reserves which helped sustain crop development through the drier months of August and September. The fall harvest had normal interruptions from rain but most farmers had completed their row crop harvesting by mid-November.

Soybeans: Production in 2001 totaled 186 million bushels, up 6 percent from the 2000 crop, and 27 percent above the 1999 production. Farmers in Missouri harvested 4.90 million of the 4.95 million acres planted in the State. Missouri yields averaged 38 bushels per acre, 3 bushels above the 2000 yield and equaling the record high set in 1992 and 1994. Nationally, Missouri ranks fifth in harvested acres (tied with Nebraska) and seventh in production. The State production is valued at \$786 million, 1 percent less than the 2000 crop.

Corn: Production during 2001 totaled 346 million bushels, 13 percent below the record high of a year earlier, but 40 percent more than the low 1999 production. Yields for the State averaged 133 bushels per acre, down 10 bushels from the record high of 2000 but 36 bushels above 2 years ago. Out of 2.70 million planted acres, corn for grain was produced from 2.60 million acres and silage was cut on 70,000 acres. The total value of grain production was estimated at \$664 million, 6 percent less than the 2000 crop. Silage yields averaged 16 tons per acre, up 1 ton from a year earlier. Silage production totaled 1.12 million tons, 24 percent above 2000.

Winter Wheat: Production in 2001 totaled 41.0 million bushels, down 17 percent from a year earlier. Of the 900,000 planted acres, farmers harvested 760,000 acres for grain. Missouri yields averaged 54 bushels per acre, 2 bushels above 2000, and equaling the record of 1997. Value of the crop is estimated at \$98.9 million, 12 percent less than the 2000 crop.

Grain Sorghum: Grain sorghum production totaled 20.7 million bushels, 17 percent less than in 2000. Of the 230,000 acres planted, 220,000 were harvested for grain, the lowest grain acreage since 1969. Average yield for the State was 94 bushels per acre, 2 bushels above the 2000 yield and the second highest on record. Grain production was valued at \$40.7 million, 7 percent less than 2000. Sorghum silage yields averaged 8 tons per acre, 1 ton above the previous year.

Cotton: Production is estimated at a record 695,000 bales, 29 percent more than in 2000. During the first year of the boll weevil eradication program, the State yield, at 834 pounds, is 166 pounds above a year earlier and the second highest on record. Missouri farmers harvested 400,000 of the 405,000 acres planted. Value of the lint is estimated at \$103 million, down 29 percent from a year earlier. Cottonseed production totaled 268,000 tons, 31 percent more than the previous year, while the value of cottonseed, at \$23.0 million, increased 24 percent.

Rice: Production during 2001 totaled a record high 12.3 million cwt, up 28 percent from a year earlier. The record high 207,000 acres harvested produced a State record yield of 5,950 pounds, 250 pounds above the 2000 average yield. Value of the crop is estimated at \$48.7 million, down 6 percent from a year earlier, as the average value per cwt. dropped 27 percent from the previous year.

Tobacco: Production in the State totaled 3.08 million pounds, 4 percent more than in 2000. The State yield of 2,370 pounds is 250 pounds higher than a year earlier. Missouri farmers harvested 1,400 acres of tobacco, which along with the previous year's level, is the lowest since records began in 1866. The tobacco crop is valued at \$5.84 million, up 6 percent from the 2000 crop.

Potatoes: Production for 2001 totaled 1.90 million cwt, 13 percent above the 2000 production. The 5,600 acres harvested produced a record yield of 340 cwt, up 65 cwt from the 2000 yield. The value of the crop is estimated at \$9.71 million, 4 percent more than the 2000 crop.

Hay: Production of all hay totaled a record 7.85 million tons, up 18 percent from 2000. The average yield for all hay at 1.94 tons was up from 1.79 tons a year earlier. Acres of Alfalfa hay were estimated at 450,000, down 4 percent from 2000. Alfalfa yields averaged 3.05 tons, 0.05 ton below a year ago, while production declined 6 percent to 1.37 million tons. Acres of all other hay increased 11 percent to 3.60 million. Yields for other hay averaged 1.80 tons, up 0.2 ton, while production increased 25 percent to a record 6.48 million tons.

Oats: Production in 2001 totaled 1.0 million bushels, 37 percent less than the 2000 crop. Of the 40,000 planted acres, 20,000 were harvested for grain. State oat yields averaged 50 bushels, down 3 bushels from last year. Value of the crop is estimated at \$1.60 million, 33 percent less than in 2000.

(Missouri Agricultural Statistics Service, Missouri Farm Facts)

Nonpoint Source Impacts

Sediment

Missouri's 1998 Water Quality Report, lists 7,601 miles of classified streams as not fully attaining designated beneficial uses due to siltation, while the 2002 Water Quality Report (DNR, in publication), reports a total of 7,741 miles or 35% of all classified stream miles as not fully attaining designated beneficial uses.

Cropland sheet and rill erosion are only partly responsible for sediment impacts to in-stream habitat with much coming from gullies and stream banks. However, erosion control practices are an important segment of appropriate best management practices with benefits for both soil conservation and prevention of movement of some pesticides and nutrients.

High rates of erosion can cause serious production problems on affected farmland. On some Missouri soils, five tons of soil erosion per acre per year is considered to be "tolerable". This rate is indicated by "T" in soil loss tables. Yet, under natural conditions, it can take 300 or more years to form one inch of soil. At the five-ton rate, it takes only 33 years to lose that inch. Typically, cropland soils can potentially be eroded significantly faster than new soil can be formed.

The National Resources Inventory (December 2000) estimated that in 1982, Missouri contained 13 million acres of cultivated cropland with an average Universal Soil Loss Equation (USLE) rate of 10.9 tons per acre per year. However, in 1997 that erosion rate decreased to 5.6 tons per acre per year on 10.5 million acres of cultivated cropland.

Table 2

Sheet and Rill Erosion on Cultivated Cropland In Missouri between 1982-1997				
	1982	1987	1992	1997
Acres of Cultivated Cropland	13,121,300	12,647,000	10,991,100	10,513,300
Average USLE Soil Loss Rate On Cultivated Cropland	10.9	8.4	6.6	5.6
Total Soil Loss On Cultivated Cropland (total tons)	142,649,800	105,754,100	72,259,400	59,097,100
Acres of Cultivated Cropland Eroding Above "T"	7,214,100	6,152,100	4,572,800	3,934,400
Average USLE Soil Loss Rate On Cultivated Cropland Eroding Above "T" (tons/acre/year)	17.4	14.7	12.2	11.0
Total Soil Loss On Cultivated Cropland Eroding Above "T" (total tons)	125,677,000	90,194,600	56,003,800	43,274,300

Additionally, trend analyses of water quality monitoring data from the last thirty years on the Missouri River at St. Louis and for the last twenty years on the Mississippi River at Alton and at Thebes, Illinois, all show a decline in suspended solids over time. (DNR, unpublished). Clearly, soil conservation programs which rely on government cost-sharing and other financial incentives are working to reduce sediment delivery to streams.

Nutrients

The need for nutrient applications is unquestionable; harvest of crops removes significant amounts of nutrients from the soil, preventing their recycling. Sources are primarily commercial fertilizers, animal manure and nitrogen-fixing legumes used as a part of crop rotations. However, nutrients leaving the field have the potential to become pollutants. In aquatic systems, growth of algae and other aquatic plants in response to nutrient input varies with light availability. In southern Missouri's clear Ozark streams and lakes, nutrients such as phosphorus and nitrogen can lead to increased aquatic plant growth. However, in northern Missouri where water bodies are less clear due to high mineral turbidity, growth of algae is restricted by the

limited penetration of light availability. Nevertheless, high nutrient concentration remains a threat to streams and reservoirs. Recently, EPA changed their interpretation of the "threatened" category and now considers it to mean that the water is impaired or will be within the next 2 years. Therefore, the Missouri Department of Natural Resources has removed it from their assessment database. Officially this change will not be shown in any department lists or publications until the 2004 305b report. (John Ford, MDNR)

Another potential threat to Missouri's drinking water reservoirs stems from nutrient enrichment enhancing algal blooms which, in turn, provide the precursors that react with chlorine (the primary drinking water disinfectant) to form disinfection byproducts (DBPs). The primary DBPs are trihalomethanes and haloacetic acids. Based on monitoring data at all of Missouri's surface water supplies during 1996, about 60% of them would have difficulty meeting EPA's proposed maximum contaminant level of 0.80 mg/L for trihalomethanes.

Nitrate occurs naturally in ground water, even under pristine conditions. Scientists generally concur that nitrate as nitrogen in ground water at concentrations above 1 mg/L is caused by human activity, although under certain conditions, the natural concentration can be higher. Concentrations of more than 10 mg/L in drinking water can cause adverse health effects in humans, most notably infants under six months of age, and in young livestock. Nitrate toxicity, or methemoglobinemia (blue baby disease), results because the blood's ability to absorb oxygen is reduced. Further, according to a study by authors from the National Cancer Institute, University of Nebraska and Johns Hopkins University, long-term exposure to elevated nitrate levels may contribute to the risk for non-Hodgkin's lymphoma (Ward, et al., 1996).

Potential nonpoint or human-induced sources for nitrate in ground water include improper well construction, feedlots, chemical mix sites and on-site sewage disposal systems such as septic tank drain fields or leaking lagoons. The available data on nitrate contamination of ground water attributable to either point or nonpoint sources indicate that it is locale-specific because so many interacting factors are involved. The occurrence and distribution of nitrate, as nitrogen, and selected pesticides in ground water in Missouri was determined using data collected between 1986 and 1994 from 854 domestic wells and 38 springs. Sampling sites were located in 81 of the 114 counties in Missouri. Hydrogeologic, well, agricultural-practice and land-use data were used in statistical analyses to determine relations to nitrate concentrations and pesticide detection frequency in ground water. More than 36 percent of the sites had nitrate concentrations in excess of 3 milligrams per liter, indicative of a possible human-related source for many sites. Almost 18 percent of the sites had (at least one sample with) nitrate concentrations equal to or in excess of the Missouri drinking-water supply criterion of 10 milligrams per liter (US Geological Survey, 1996).

Elevated nitrate concentrations in ground water were significantly related to aquifer, well depth, well diameter, water-level depth below the land surface, well distance to a feed lot, and well distance from a chemical mixing area. (A chemical mixing area refers to an area where any kind of agricultural chemical, either fertilizer or pesticide, was mixed.) Ground water from glacial drift or Pennsylvanian rocks had significantly higher concentrations of nitrate than did ground water from alluvial, Mississippian/Springfield Plateau, or Cambrian-Ordovician/Ozark aquifers. Water samples from wells less than 75 feet deep, greater than 6 inches in diameter, and where

the water level was less than 50 feet from the land surface had significantly higher nitrate concentrations than samples from other wells. Water samples from wells less than 0.25 mile from a feedlot and wells where chemicals were mixed within 100 feet of the well had significantly higher nitrate concentrations than samples from other wells (US Geological Survey, 1996).

Pesticides

Increasing environmental concerns, technological developments, increased costs of inputs and changing soil conservation measures have brought about significant changes and trade-offs in farming practices in Missouri. As effective, relatively inexpensive herbicides were developed, producers adopted their use as an alternative to extra cultivation. With widespread use, however, the herbicides began appearing in water bodies. Of particular importance in Missouri is the presence of atrazine and other herbicides in reservoirs used for drinking water. Passage of the Safe Drinking Water Act, which eventually limits the levels of certain contaminants in drinking water, including atrazine, has brought the issue to the forefront. Lakes are particularly at risk because of retention time; late spring runoff events generally carry a flush of recently applied pesticides, which may move slowly through the system. Or, in the case of drinking water reservoirs, the spring flush may be held for use throughout the remainder of the year. In 2003, over half (55/96) of the surface drinking water supplies had measurable levels of pesticides in the finished water.

Nationally, use of conservation tillage increased annually in the early 1990's, but between 1998 and 2002, conservation tillage decreased over 6 million acres. Conservation tillage practices (no-till, mulch-till, and ridge-till) leave 30 percent or more crop residue on the soil surface decreasing soil erosion, increasing moisture infiltration, reducing farmers' fuel consumption, adding organic matter and increasing tilth. Missouri has followed the national trend of reduction in the use of conservation tillage starting in 1998 from 5.5 million acres through 2002 at 3.9 million acres (Conservation Technology Information Center, 2002).

<http://www.ctic.purdue.edu/Core4/CT/CT.html>

Conservation tillage requires trade-offs; increased use of pesticides, particularly herbicides, is frequently necessary. From 1989 to 1992 there was a three-fold increase in the amount of the nonspecific, "burndown" herbicide glyphosate used (Becker, et al., 1992). Also, with increased moisture infiltration comes a greater risk of ground water contamination from percolating nutrients and pesticides.

(Atrazine BMP's and Alternatives in Missouri UMC Publication 4851, 1996)

<http://muextension.missouri.edu/xplor/agguides/crops/g04851.htm>

In the study cited above (US Geological Survey, 1996), pesticides were detected in ground water much less frequently than nitrate, and at much lower concentrations. Concentrations of at least one pesticide exceeded the maximum contaminant level or health advisory limit in 1.9 percent of samples. Atrazine, the most widely used herbicide, was the most frequently detected pesticide in the small number of detections.

Pesticide detections in groundwater samples were significantly related to aquifer, well depth, well diameter, water-level depth below land surface, distance from well to a chemical mixing

area, and nitrate concentrations. Water samples from wells less than 75 feet deep, greater than 6 inches in diameter, and where the water level was within 50 feet of the land surface were more prone to pesticide detections than samples from other wells. Water samples from wells where chemicals were mixed less than 100 feet from the well were 3.4 times more likely to have a pesticide detection than water from wells where pesticides were mixed at distances greater than 0.25 mile from the well. Ground water in areas susceptible to elevated pesticide concentrations also had significantly higher nitrate concentrations. The data indicate the presence of elevated nitrate and pesticide concentrations in ground water within the State, although they primarily are associated with practices that occur near the wellhead, are likely to be localized and limited to shallow ground water (US Geological Survey, 1996).

Irrigation

Irrigation usage in Missouri ranges from supplemental on upland areas to ensure adequate moisture during key crop growth stages to essential in sandy alluvial soils and in production of rice or specialty crops. Application methods are primarily sprinkling, furrow and flood, and use in Missouri is increasing. Between 1987 and 1992 irrigated acreage in Missouri increased from 529,000 acres or 4.5 percent of harvested cropland acres to 705,000 acres or 5.8 percent of Missouri harvested cropland acreage, a 33 percent increase. (Bureau of the Census, 1997.) Missouri continued to increase the amount of irrigated acres through the 1990's, as is indicated in the 1997 Census of Agriculture with 832,591 irrigated acres. (US Census of Agriculture): <http://www.nass.usda.gov/census/>.

Generally irrigation water sources are plentiful in Missouri, and energy costs low, allowing application methods and management practices which make inefficient use of water resources and chemicals. Over-application contributes to increased pumping costs and reduced nutrient and pesticide efficacy due to leaching or runoff which in turn requires additional chemical inputs. "Chemigation" and "fertigation," the delivery of chemicals and fertilizer through irrigation, are efficient application methods, but may become ground water pollution point sources when backflow devices are not a part of the system.

Agricultural fertilizers and chemicals removed from their target site and use become pollutants. Irrigation management methods developed in areas of the country where irrigation water is costly and scarce are designed to reduce off-site movement of irrigation water and its associated chemical load. Some of those methods, i.e. surge and side inlet rice irrigation are useful and applicable in Missouri. Site specific irrigation management methods considering soil type and water holding capacity, topography, crop moisture needs, rainfall, soil moisture and nutrient and pesticide management plans require closer attention to irrigation management and possibly changes in application methods and equipment used, but can significantly reduce material input costs, yield loss, and the potential for nonpoint source pollution.

Riparian Corridors

One pervasive result of crop production has been degradation or destruction of riparian corridors, much of which occurred early in the 20th century when channelization was customary and recommended. Whether for preventing flooding, farming convenience or for placing more land into production, streams have been straightened, forested or vegetated buffer strips have been removed, and farming occurs directly to the stream bank. The results to streams are increased

sedimentation from destabilized stream banks, loss of pollutant trapping effects from vegetation, increased temperature and evaporation, lowered dissolved oxygen and a degraded physical habitat.

Good physical habitat usually means a mixture of shallow, fast-flowing riffles, deep quiet pools and areas of medium depth and current speed. It also means a mixture of stream substrate sizes ranging from boulders to large cobbles to gravels, sands and silt, scattered emergent aquatic plants, rootwads and downed trees. In short, good habitat means a mixture of physical attributes of the stream channel.

These conditions are more common in Ozark streams where the rock strata weather into coarse cobble and gravel as well as finer sized material, and where there is a good mixture of pools and riffles, wooded stream banks, rootwads and dead falls. This type of diverse aquatic habitat is much less common in other areas of the state.

Regional geology and upstream land use in Glacial Till and Osage Plains make for a less diverse aquatic habitat. The till and the rock strata of the plains weather into sands and silts so that stream substrates are finer and less stable than in Ozark streams. These factors in combination with channelization and removal of riparian corridors result in fewer pools and riffles and contribute to higher temperatures, increased evaporation and the inability of many of these streams to maintain flow in dry weather.

Researchers have found these factors, rather than water quality, to be responsible for significant differences in fish and aquatic invertebrate communities; among these, maximum water temperature, siltation, and minimum dissolved oxygen appear to be important. These factors, particularly dissolved oxygen and temperature, correlate well with the condition of the riparian zone; heavily degraded riparian zones have more bank erosion, higher maximum temperatures, and lower minimum dissolved oxygen levels (Smale, et al., 1992).

Nonpoint Source Controls

Control of nonpoint water pollution sources such as runoff from farms, cities, mining areas and construction sites is still essentially a voluntary program. Regulations are in place to prevent leakage from underground storage tanks and for the secondary containment of bulk agricultural chemical storage sites. Large sand and gravel mining operations require a general NPDES permit for stormwater and smaller operations have been provided with guidelines for best management practices (BMPs). A Land Reclamation Permit is required of larger mining operations as well as a 404 permit required for some sand and gravel operations. Stormwater runoff discharge permits are now issued for construction sites and other areas with less than five acres of bared ground. The Water Protection Program has reduced the size of bared ground requiring a stormwater permit from five acres to one acre.

Control of many nonpoint sources, such as agricultural erosion from cropland and pasture, runoff of fertilizer, pesticides and animal waste, are addressed by Missouri's nonpoint source management program. This program works with federal, state and local governments, universities, private groups and individual landowners to implement watershed projects that demonstrate nonpoint source control practices and often monitor water quality results.

Programs with dedicated funding sources have worked best. A tax on coal has funded reclamation of abandoned coal mine lands nationwide, although the federal grant was not awarded to Missouri for 2004. Fourteen years of such reclamation in Missouri has reduced the number of stream miles impaired by acid mine drainage from about 100 down to 15. A state sales tax for soil erosion control started providing funds for watershed level soil erosion control programs in 1985. This program, coupled with federal soil conservation programs, is reducing soil erosion in Missouri based on the findings of periodic National Resource Inventories.

Major Water Pollution Sources and Contaminants

TABLE 3. MAJOR WATER POLLUTION SOURCES IN MISSOURI CLASSIFIED WATERS
(Stream Miles or Lake Acres Impaired)

Source	Stream Miles Impaired	Percent of Total Miles	Lake Acres Impaired	Percent of Total Acres
Agriculture	7,701.9	35	45,138	15
Crop Production/Grazing	7,688.4	35	45,138	15
Confined Animal Feeding	4.0	*		
Hydromodification	3,775.9	17	11,780	4
Channelization	3,711.4	17		
Flow Regulation/Modific.	43.5	*	11,780	4
Streambank Mod./Destab.	21	*		
Mining	172.3	1		
Municipal and other Domestic Point Sources	87.1	*	43110	15
Urban Runoff and Construction	53.5	*	825	*
Industrial Point Sources	11.6	*		
Landfills	0.3	*		
Recreational Activities	7	*		
Atmospheric Deposition	1,114	5	76,805	26
Natural Sources	162.5	1		
Unknown	5	*	182	*

* less than 1 %

TABLE 4
MAJOR CONTAMINANTS IN MISSOURI CLASSIFIED WATERS

Contaminant	Stream Miles Impaired	% of Total Miles	Lake Acres Impaired	% of Total Acres
Sediment	7,741.4	35	--	--
Habitat Degradation	3,734.3	17	--	--
Organic Enrichment /Low D.O.	59.5	*	1780	1
Metals	1,444.0	6	86,805	30
Mercury	1,111.0	5	76,805	26
Bacteria	48.5	*	137	*
Ammonia	18.3	*	--	--
Pesticides	24	*	1,385	*
Suspended Solids	8.8	*	--	--
Nutrients	7.4	*	44,578	15
TDS: Sulfate, Chloride	39	*	--	--
Flow Alterations			50	*
Chlorine	0.4	*		
pH	13.3	*		
Thermal Modification	1.4	*		
Unknown	21.7	*		

* less than 1 %.

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Best Management Practices (BMPs)

In general the following three aspects of agricultural production are critical to determining what effect agriculture has on water quality and which BMPs will be the most effective.

Some common agricultural pollutants resist degradation once they enter water bodies. Evidence shows that atrazine, for example, can remain in large lakes and reservoirs for months.

Consequently, it is important to detect risks to drinking water and aquatic habitat early where technologies may prevent pollution from getting into the water in the first place.

Agricultural pollutants have a tendency to travel once they are waterborne. Therefore, assessing the vulnerability or actual degradation of water quality associated with agriculture may entail monitoring fairly large drainage systems. For example, pollution loadings near a single farm may be too low to trigger concern, but pollutants transported through streams and rivers from

many farms can accumulate to significant amounts at some terminal drainage points. An example occurs in the Mississippi Drainage Basin where pesticide, nutrient and sediment loadings accumulate and reach hundreds of thousands of tons by the time the river reaches the Gulf Coast estuaries of Louisiana.

Surface water, ground water, wetlands and water conservation conditions are interrelated. Movements of nutrients and pesticides between ground water and surface water are well documented. As discussed above, use of BMPs designed to prevent erosion may have adverse effects on quality of both surface and ground water (Office of Technology Assessment, 1995).

Wide ranges of voluntary and incentive programs are in place, the majority of which are designed to prevent soil erosion. Assistance is available in the form of educational materials, technical assistance, training, specialized mechanical equipment, cost-share assistance and incentive payments. A discussion of those programs may be found in the Implementation Assistance Section, Appendix J. An extensive list of best management practices is included at the end of this agriculture section. New, innovative practices which have yet to establish a proven track record may also be considered on a site specific basis as long as monitoring is included to prove or disprove the practice's efficacy.

ANIMAL PRODUCTION

Characterization

It is well documented that the animal production contributions to Missouri's economy are significant and continuing to increase. All animal sectors are experiencing growth in the number of larger operations while the total number of operations is continuing to decline.

Medium Concentrated Animal Feeding Operation (Medium CAFO)

The term Medium CAFO includes any AFO with the type and number of animals that fall within any of the ranges listed below and which has been defined or designated as a CAFO. An AFO is defined as a Medium CAFO if:

The type and number of animals that it stables or confines falls within any of the following ranges:

200 to 699 mature dairy cows, whether milked or dry;

300 to 999 veal calves;

300 to 999 cattle other than mature dairy cows or veal calves. Cattle includes but is not limited to heifers, steers, bulls and cow/calf pairs;

750 to 2,499 swine each weighing 55 pounds or more;

3,000 to 9,999 swine each weighing less than 55 pounds;

150 to 499 horses;

3,000 to 9,999 sheep or lambs;

16,500 to 54,999 turkeys;

9,000 to 29,999 laying hens or broilers, if the AFO uses a liquid manure handling system;

37,500 to 124,999 chickens (other than laying hens), if the AFO uses other than a liquid manure handling system;

25,000 to 81,999 laying hens, if the AFO uses other than a liquid manure handling system;

10,000 to 29,999 ducks (if the AFO uses other than a liquid manure handling system); or

1,500 to 4,999 ducks (if the AFO uses a liquid manure handling system); and

Either one of the following conditions are met:

Pollutants are discharged into waters of the United States through a man-made ditch, flushing system, or other similar man-made device; or

Pollutants are discharged directly into waters of the United States which originate outside of and pass over, across, or through the facility or otherwise come into direct contact with the animals confined in the operation. [40 CFR 122.23(b)(6)]

Animal production facilities considered nonpoint sources are generally small operations. Animal operations with livestock numbers greater than those referenced above are required to have NPDES permits and are, therefore, point sources by definition. Smaller operations may also be designated as point sources for permit purposes based on site-specific conditions (e.g., discharges). The new Concentrated Animal Feeding Operation (CAFO) rules published February 12, 2003, in the *Federal Register* were adopted within the authority of the 1972 Clean Water Act as amended to address changes in the animal production industries and their developments. These new rules are the result of more than 3 years of high-profile study and input from the animal feeding industry, academia, environmental groups, and the general public through which EPA considered a wide range of potential options that were evaluated technically and economically.

EPA's revisions to the original regulations make the regulations more effective for the purpose of protecting or restoring water quality. The revisions also make the regulations easier to understand and better clarify the conditions under which an AFO is a CAFO, and therefore, subject to the regulatory requirements. They are more inclusive of certain sectors of the CAFO industries, removed several registration exemptions, reflect a greater focus on land application of manure and wastewater, and emphasize accountability, inspections, and record-keeping while retaining appropriate state flexibility.

There are 20 Class I and 380 Class II confined animal feeding operations (CAFOs) located in Missouri. These facilities generate large amounts of animal manure and have the potential to cause serious water pollution problems. We are also concerned by cumulative impacts of numerous small animal production facilities.

For more information regarding the CAFO rule and related materials, select the following links:

<http://cfpub.epa.gov/npdes/afo/cafofinalrule.cfm> or <http://agebb.missouri.edu/commag/news/srcafo.htm>.

Nonpoint Source Impacts

Nonpoint sources of pollution related to animal production include four major areas: eutrophication or nutrient enrichment, pathogens, ammonia toxicity, and riparian habitat disruption. The first two are related to the management of animal waste which are generally applicable to all animal types while the third is related only to pastured animals. In addition, animal food additives such as metals (copper, selenium, mercury, etc.), hormones and antibiotics may have impacts on aquatic organisms or human populations. Metals in runoff may have chronic or acute impacts on aquatic organisms, hormones may cause the disruption of reproduction in aquatic animals and antibiotics may support the proliferation of antibiotic resistant strains.

Nutrients/Eutrophication

Excess nutrients may have water quality impacts on beneficial uses of streams and lakes as well as ground water. Aquatic life may be impaired by the growth and subsequent decomposition of algae and aquatic macrophytes with the resulting depletion of dissolved oxygen in the water column. One form of nitrogen, ammonia, is toxic to aquatic life at certain levels. Species of fish and invertebrates may be replaced by more tolerant species. Aesthetic impairment may also occur. In waters used for drinking water supply, taste and odor problems can be caused by the proliferation of organism growth due to high levels of nutrients entering the water. Organic matter in drinking water supplies can cause increased levels of trihalomethanes in finished drinking water. The nitrate form of nitrogen can cause health problems in children (methemoglobinemia).

Pathogens

Animal waste has potential for spreading or encouraging pathogens that may damage aquatic life or humans. Algal toxicity from eutrophication has been well documented in one Missouri drinking water reservoir earlier this decade (City of Lamar reservoir). Blooms of blue-green algae are becoming more common due to increased nutrient inputs to water sources. The outbreak of *Cryptosporidium*, a parasitic protozoan, in the City of Milwaukee's water supply was attributed to animal waste in drinking water among other possible sources. Although at this point problems associated with *Pfiesteria* appear to be limited to marine or estuarine environments, that organism's toxicity has been linked to nutrient enrichment in the affected waters, and some of those nutrients are attributed to animal production sources.

Ammonia Toxicity

Animal waste typically contains a significant level of ammonia. Fish populations are very sensitive to relatively low levels of ammonia. Most fish kills related to animal waste are caused by ammonia in the waste. The water quality standards contain numeric criteria for ammonia in classified waters, and the level of toxic form of ammonia is related to temperature and pH. Under proper containment and management, animal waste is not discharged to water and the nitrogen in the ammonia form does not run off application sites in any significant concentration.

Riparian Corridors/Sediment

Livestock with free access to waters generally cause bank instability, bank sloughing and erosion of the riparian area, in addition to the direct introduction of nutrients and possibly pathogens into the water. The loss of vegetation contributes to increased temperature and evaporation, lowered dissolved oxygen and a degraded habitat. In addition to the immediate impacts in the riparian area, the filtering properties of the riparian strip, which would otherwise buffer the water from sediment or other contaminants, are lost.

Best Management Practices (BMPs)

In general the best management practices for animal production emphasize the physical separation of animals and their wastes from waters. This is accomplished in several ways: 1) management of animal wastes such that wastes that are collected are prevented from running off directly into waters; 2) wastes that are utilized as fertilizers and applied at agronomic rates such that there is no excess nutrient load which could leach or run off into waters from the fields to which they were applied, and 3) livestock are separated from waters.

A wide range of voluntary and incentive programs are in place, the majority of which are designed to prevent pollution by animal waste or the degradation of riparian areas by animal use. Assistance is available in the form of educational materials, technical assistance, training, specialized mechanical equipment, cost-share assistance and incentive payments, both for management as well as pollution prevention or habitat restoration. A discussion of those programs may be found in the Implementation Assistance Section, Appendix J. An extensive list of best management practices is included at the end of this agriculture section.

Recommendations

The Farm Security and Rural Investment Act of 2002 is landmark legislation for conservation funding and for focusing on environmental issues. The conservation provisions will assist farmers in meeting environmental challenges on their land. This legislation simplifies existing programs and creates new programs to address high priority environmental and production goals. The 2002 Farm Bill enhances the long-term quality of our environment and conservation of our natural resources. (2002 USDA Farm Bill): <http://www.usda.gov/farmbill/>

Nonpoint source water pollution must be addressed within the context of sustainability; solutions must be economically and environmentally sound. Nonpoint source funding and project efforts should address information and education, to develop awareness of problems, their causes and solutions, emphasizing practices that protect environmental quality and economic viability. Demonstrations and technical assistance should be used to provide reasonable, effective alternatives. Projects should focus on sustainable strategies incorporating management systems such as whole farm planning; integrated crop management; integrated pest management; realistic yield goals, restoration of riparian corridors; alternative crops or farming systems, e.g. intensively managed grazing or agroforestry versus row crop production; etc.

Temporary or permanent riparian corridor and wetland conservation easements could provide substantial water quality and habitat benefits. One ~~major~~ impediment to easement establishment appears to be continued tax liability to the landowner. Removal or reduction of the tax liability on property consigned to long term conservation easements could make the practice more attractive to landowners.

On March 9, 1999, USDA and EPA released the Unified National Animal Feeding Operations Strategy. This strategy includes actions contemplated with regard to nonpoint sources as well as permitted animal feeding operations. Copies of the strategy are available at USDA-NRCS field offices and the state office. Copies are also available from the Missouri Manure Management Action Group via the internet at <http://outreach.missouri.edu/mommag>.

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AGRICULTURAL BEST MANAGEMENT PRACTICES

Agricultural Best Management Practices (BMPs) for pollution control are those management practices and structural measures which are determined to be the most effective, practicable means of controlling and preventing pollution from agricultural activities. BMPs are singular practices that, when put together in combination with other practices, will reduce soil erosion, nutrient and pesticide runoff or leaching, and manage animal manures. BMPs are actions taken by each individual agricultural operation for the achievement of production and water quality protection.

Appropriate management practices for individual farms may vary with the specific cropping, topographical, environmental, and economic conditions existing at a given site. Due to these variables, it is not possible to recommend uniform BMPs for farms

A detailed, but not all inclusive, listing of a number of specific practices and management measures which can be employed to control or reduce the risk of agricultural pollution and their potential impacts are contained in the listings which follow. Technical specifications may be found in the *Field Office Technical Guide* maintained by the USDA Natural Resources Conservation Service http://efotg.nrcs.usda.gov/efotg_locator.aspx?map=MO.

BMPs and land use changes are most effective when selected and installed as integral parts of a comprehensive resource management plan based on natural resource inventories and assessment of management practices. The result is an approach using the Best Management Systems concept. Best Management systems use BMPs and land use changes which are designed to be complementary, and when used in combination are more technically sound than each practice separately. Components selected in plan development must consider the over-all desired result; therefore, the opportunity to incorporate new and developing technologies and innovative practices must remain viable.

**NONPOINT SOURCE WATER QUALITY
CONSERVATION PRACTICE EFFECTS RANKING***
11/03

<u>Significant Positive</u> Water Quality Benefit or Control	+2
<u>Good</u> Water Quality Benefit or Control	+1
<u>Negligible Water</u> Quality Benefit or Control	0
<u>Negative</u> Water Quality Impact	-1
<u>Significant Negative</u> Water Quality Impact	-2
<u>Variable (Positive or Negative)</u> Water Quality Impact	+/-
Conservation Practice <u>Not Applicable</u> to Water Quality	NA

* The numeric ranking is intended to be only a general guideline. Positive and negative impacts will vary from site to site. The conservation practices listed are examples and may change for each specific location. Specific conservation practices may be used for more than one resource concern.

Soil Tilth, Crusting, Water Infiltration, Organic Materials

Soil condition based on suitable combinations of mineral, water, air, organic matter, resulting in proper habitat for microbial activity and chemical reactions to occur.

Soil Compaction

Excess compression of soil particles and aggregates by machine, livestock, and natural consolidation, thereby affecting plant-soil-moisture-air relationships.

Soil Contaminants

Other Excess Animal Manures and Organics

Excess animal waste and other organics restrict the desired soil use.

Excess Fertilizers

Quantity of nutrients restricts desired soil use.

Damage On-site

Need to rework ground due to sediment thickness and distribution; crops destroyed; infertile deposition, especially for coarse textured soils.

Damage Off-site

Same as on-site damage. Off-site practice effects are less than on-site because of increased distance from source of problem.

Suspended Sediment and Turbidity

Suspended sediment is sediment held in surrounding fluid; turbidity is reduced clarity of fluids due to the presence of matter.

Aquatic Habitat Suitability

Water quality and physical nature of the stream provide a suitable home for fish and other aquatic life.

TABLE 5: NONPOINT SOURCE WATER QUALITY IMPACTS DERIVED FROM EROSION CONTROL PRACTICES APPLIED TO AGRICULTURAL LANDS FOR (SEDIMENT) 11/03

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL TILTH, CRUSTING, WATER INFILTRATION, ORGANIC MATERIALS	SOIL COMPACTION	SOIL CONTAMINANTS			DAMAGE ONSITE	DAMAGE OFFSITE	SUSPENDED SEDIMENT AND TURBIDITY	AQUATIC HABITAT SUITABILITY
			OTHER EXCESS ANIMAL MANURES AND ORGANIC	EXCESS FERTILIZERS	EXCESS PESTICIDES				
ACCESS ROAD (560)	NA	+1	+2	+1	+1	+1	+1	+1	+1
BRUSH MANAGEMENT (BIOLOGICAL) (314B)	+1	+1	0	0	+1	+2	+1	+1	+/-
BRUSH MANAGEMENT (CHEMICAL) (314C)	+1	+1	0	0	-2	+2	+1	+1	+/-
BRUSH MANAGEMENT (MECHANICAL) (314M)	+1	-1	0	0	NA	+/-	+/-	-1	-1
BRUSH MANAGEMENT (BURNING) (314F)	+/-	+/-	0	0	NA	+/-	+/-	-1	-1
CHISELING AND SUB-SOILING (324A)	+1	+2	0	0	0	0	0	+1	NA
CHISELING AND SUB-SOILING (324B)	+1	+2	0	0	0	0	0	+1	NA
CLEARING AND SNAGGING (326)	NA	NA	NA	NA	NA	+/-	-1	-1	-2
COMMERCIAL FISHPONDS (397)	0	0	+2	+1	+1	+1	+1	+1	+1
CONSERVATION COVER (327)	+2	+1	+1	+1	+1	+2	+2	+1	+1
CONSERVATION CROP ROTATION (328)	+2	+2	+1	+1	+1	+1	+1	+1	+1
CONTOUR BUFFER STRIPS (332)	UNDETERMINED	UNDETERMINED	+2	+2	+2	+2	+2	+2	+2

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL TILTH, CRUSTING, WATER INFILTRATION, ORGANIC MATERIALS	SOIL COMPACTION	SOIL CONTAMINANTS			DAMAGE ONSITE	DAMAGE OFFSITE	SUSPENDED SEDIMENT AND TURBIDITY	AQUATIC HABITAT SUITABILITY
			OTHER EXCESS ANIMAL MANURES AND ORGANIC	EXCESS FERTILIZERS	EXCESS PESTICIDES				
CONTOUR FARMING (330)	+2	0	+1	+1	+1	+2	+2	+1	0
COVER AND GREEN MANURE CROP (340)	+2	+2	+1	+1	+1	+2	+2	+1	+1
CRITICAL AREA PLANTING (342)	+2	+2	+1	+1	+1	+2	+2	+1	+1
CROSS WIND RIDGES (589A)	+1	+1	+1	+1	+2	+2	+2	+1	+1
CROSS WIND STRIP CROP (589B)	+2	+1	+1	+1	+1	+2	+2	+1	+1
CROSS WIND TRAP STRIP (589C)	+1	+1	+1	+1	+1	+2	+2	+1	+1
DAM, DIVERSION (348)	+1	+1	+1	+1	+1	+1	+1	+1	0
DAM, FLOODWATER RETARDING (402)	0	0	+1	+1	+1	+1	+1	+1	+1
DAM, MULTIPLE PURPOSE (349)	0	0	+1	+1	+1	+/-	+/-	+1	+1
DEFERRED GRAZING (352)	+2	+1	+2	+2	+2	+1	+1	+1	+1
DEEP TILLAGE (INTERIM) (XXX)	+1	+2	+/-	+/-	+/-	NA	+/-	+/-	NA
DIKE (EARTHEN) (356)	0	0	+1	+1	+1	+1	+1	+1	+1
DIVERSION (362)	0	0	+1	+1	+1	+1	+1	+1	0
FENCING (382)	+1	+1	+1	+1	+1	+1	+1	+1	+1
FIELD BORDER (386)	+1	+1	+1	+1	+1	+1	+1	0	+1

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL TILTH, CRUSTING, WATER INFILTRATION, ORGANIC MATERIALS	SOIL COMPACTION	SOIL CONTAMINANTS			DAMAGE ONSITE	DAMAGE OFFSITE	SUSPENDED SEDIMENT AND TURBIDITY	AQUATIC HABITAT SUITABILITY
			OTHER EXCESS ANIMAL MANURES AND ORGANIC	EXCESS FERTILIZERS	EXCESS PESTICIDES				
FIELD WINDBREAK (392)	+1	+1	+1	+1	+1	NA	NA	+1	+1
FILTER STRIP (393)	0	0	+1	+1	+1	+2	+1	+2	+2
FIREBREAK (394)	+1	NA	+/-	+/-	+/-	NA	NA	+/-	NA
FISHPOND MANAGEMENT (399)	NA	NA	+1	+1	+1	NA	NA	+1	+1
FOREST STAND IMPROVEMENT (666)	+1	-1	NA	NA	+/-	+	+	+/-	NA
GRADE STABILIZATION STRUCTURE (410)	NA	NA	0	0	0	+1	+1	+1	0
GRASSED WATERWAY (412)	0	0	+/-	+/-	+/-	+1	+1	+1	0
GRASSES AND LEGUMES(ROTATION) (411)	+2	+1	+1	+1	+2	+1	+1	+2	+1
HEAVY USE AREA PROTECTION (561)	+1	+1	+1	+1	+1	+1	+1	+2	+1
HEDGEROW PLANTING (422)	0	+1	+1	+1	+1	+1	+1	+1	+/-
HERBACEOUS WIND BARRIERS (422A)	+1	+1	+1	+1	+1	+1	+1	+1	+/-
IRRIGATION FIELD DITCH (388)	0	0	-1	-1	-1	0	0	+/-	0
IRRIGATION LAND LEVELING (464)	0	+/-	+1	+1	+1	0	0	+1	0
IRRIGATION PIT (552)	0	0	+1	+1	+1	+1	+1	+1	0

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL TILTH, CRUSTING, WATER INFILTRATION, ORGANIC MATERIALS	SOIL COMPACTION	SOIL CONTAMINANTS			DAMAGE ONSITE	DAMAGE OFFSITE	SUSPENDED SEDIMENT AND TURBIDITY	AQUATIC HABITAT SUITABILITY
			OTHER EXCESS ANIMAL MANURES AND ORGANIC	EXCESS FERTILIZERS	EXCESS PESTICIDES				
IRRIGATION STORAGE RESERVOIR (436)	0	0	+1	+1	+1	+1	+1	+1	0
IRRIGATION SYSTEM - TRICKLE (MICRO) (441)	+1	+1	+1	+1	+1	+1	+1	+1	0
IRRIGATION SYSTEM - SPRINKLER (442)	-1	+1	+1	+1	+1	+2	+2	+2	0
IRRIGATION SYSTEM - SURFACE AND SUBSURFACE (443)	0	-1	+1	+1	+1	+1/+2	+1/+2	+1	-1
IRRIGATION SYSTEM - TAILWATER RECOVERY (447)	0	0	+1	+1	+1	+1	+1	+1	+1
IRRIGATION WATER CONVEYANCE - (DITCH) (428)	0	NA	0	0	0	0	0	0	0
IRRIGATION WATER CONVEYANCE -(PIPELINE) (430)	0	NA	0	0	0	0	0	0	0
IRRIGATION WATER MANAGEMENT (449)	+2	+1	+1	+1	+1	+2	+2	+1	+1
LAND RECONSTRUCTION (ABANDONED MINE LAND) (543)	+1	+1	+1	+1	+1	+2	+2	0	0
LAND RECONSTRUCTION (CURRENT MINE LAND) (544)	+1	+1	0	0	0	+2	+2	+1	+1
LAND SMOOTHING (466)	+/-	0	+/-	+/-	+/-	0	0	0	0
LINED WATERWAY OR OUTLET									

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL TILTH, CRUSTING, WATER INFILTRATION, ORGANIC MATERIALS	SOIL COMPACTION	SOIL CONTAMINANTS			DAMAGE ONSITE	DAMAGE OFFSITE	SUSPENDED SEDIMENT AND TURBIDITY	AQUATIC HABITAT SUITABILITY
			OTHER EXCESS ANIMAL MANURES AND ORGANIC	EXCESS FERTILIZERS	EXCESS PESTICIDES				
(468)	0	0	0	0	0	+1	+1	+/-	0
MULCHING (484)	+2	+1	+1	+1	+1	+1	+1	+1	+1
NUTRIENT MANAGEMENT (DEFICIT) (590D)	-1	NA	+/-	+/-	NA	0	0	+1	+1
NUTRIENT MANAGEMENT (EXCESS) (590E)	+2	NA	-2	-2	NA	0	0	-1	+1
OBSTRUCTION REMOVAL (500)	0	0	0	0	0	-1	-1	-1	-2
OPEN CHANNEL (582)	NA	NA	0	0	0	+1	+1	-1	-2
PASTURE AND HAYLAND MANAGEMENT (510)	+2	+1	+1	+1	+1	+1	+1	+1	0
PASTURE AND HAYLAND PLANTING (512)	+2	+1	+1	+1	+1	+1	+1	+1	+1
PEST MANAGEMENT (BIOLOGICAL) (595B)	NA	NA	NA	NA	+2	0	0	0	NA
PEST MANAGEMENT (CHEMICAL) (595C)	NA	NA	NA	NA	+2	+/-	+/-	0	NA
PEST MANAGEMENT (MECHANICAL) (595M)	NA	NA	NA	+1	+2	+/-	+/-	+/-	NA
PIPELINE (516)	0	0	NA	NA	NA	0	0	NA	NA
PLANNED GRAZING SYSTEM (556)	+2	0	+1	+1	+1	+1	+1	+1	+1
POND (378)	NA	0	+/-	+/-	+/-	+1	+1	0	0

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL TILTH, CRUSTING, WATER INFILTRATION, ORGANIC MATERIALS	SOIL COMPACTION	SOIL CONTAMINANTS			DAMAGE ONSITE	DAMAGE OFFSITE	SUSPENDED SEDIMENT AND TURBIDITY	AQUATIC HABITAT SUITABILITY
			OTHER EXCESS ANIMAL MANURES AND ORGANIC	EXCESS FERTILIZERS	EXCESS PESTICIDES				
POND SEALING OR LINING (521)	+1	+1	0	0	0	0	0	0	0
POULTRY COMPOSTING FACILITY (313A)	0	0	+2	+1	+1	+1	+1	+2	+2
PRECISION LAND FORMING (462)	0	0	+1	+1	+1	0	0	0	0
PRESCRIBED BURNING (338)	UNDETERMINED	NA	-1	-1	+1	0	0	-1	-1 +/-
PROPER GRAZING USE (528)	+1	0	+1	+1	0	+1	-1	+1	+1
PROPER WOODLAND GRAZING (530)	-1	-1	0	0	NA	-1	-1	-1	-1
PUMPING PLANT FOR WATER CONTROL (533)	0	0	0	0	0	0	0	0	0
RECREATION AREA IMPROVEMENT (562)	+1	+1	+1	+1	+1	+1	+1	+1	+1
RECREATION LAND GRADING AND SHAPING (566)	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
RECREATION TRAIL AND WALKWAY (568)	+1	+1	+/-	+/-	0	+1	+1	+1	+1
RESIDUE MANAGEMENT (NO TILL/ STRIP) (329A)	+2	+2	+1	+1	+1	+1	+1	+1	+1
RESIDUE MANAGEMENT (MULCH TILL) (329B)	+2	+1	+1	+1	+1	+1	+1	+1	+1
RESIDUE MANAGEMENT	+2	+1	+1	+1	+1	+1	+1	+1	+1

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL TILTH, CRUSTING, WATER INFILTRATION, ORGANIC MATERIALS	SOIL COMPACTION	SOIL CONTAMINANTS			DAMAGE ONSITE	DAMAGE OFFSITE	SUSPENDED SEDIMENT AND TURBIDITY	AQUATIC HABITAT SUITABILITY
			OTHER EXCESS ANIMAL MANURES AND ORGANIC	EXCESS FERTILIZERS	EXCESS PESTICIDES				
(RIDGE TILL) (329R)									
RESIDUE MANAGEMENT (SEASONAL) (344)	+2	+1	+1	+1	+1	+1	+1	0	+1
RIPARIAN FOREST BUFFER (391)	+1	+1	+2	+2	+2	+1	+1	+2	+2
ROW ARRANGEMENT (557)	+1	+1	+1	+1	+1	+1	+1	+1	0
RUNOFF MANAGEMENT SYSTEM (570)	+1	+1	+1	+1	+1	+2	+2	+2	0
SEDIMENT BASIN (350)	0	0	+1	+1	+1	+2	+2	+2	+1
SPOIL SPREADING (572)	0	-1	+/-	+/-	+/-	-1	-1	0	0
SPRING DEVELOPMENT (574)	0	0	0	NA	NA	0	0	+1	0
STREAMBANK AND SHORELINE PROTECTION (580)	0	0	+1	+1	+1	+1	+1	+1	+1
STREAM CHANNEL STABILIZATION (584)	0	0	+1	+1	+1	+1/+2	+1/+2	+1	+1
STRIPCROPPING (CONTOUR) (585)	+2	+1	+2	+2	+2	+1	+1	+1	+1
STRIPCROPPING (FIELD) (585)	+1	+1	+2	+2	+2	+1	+1	+1	+1
STRUCTURE FOR WATER CONTROL (587)	0	+1	+1	+1	+1	0	0	0	+2
SUBSURFACE DRAIN (606)	+1	+1	-1/-2	-1/-2	-1/-2	+1	+1	+1	-2

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL TILTH, CRUSTING, WATER INFILTRATION, ORGANIC MATERIALS	SOIL COMPACTION	SOIL CONTAMINANTS			DAMAGE ONSITE	DAMAGE OFFSITE	SUSPENDED SEDIMENT AND TURBIDITY	AQUATIC HABITAT SUITABILITY
			OTHER EXCESS ANIMAL MANURES AND ORGANIC	EXCESS FERTILIZERS	EXCESS PESTICIDES				
SURFACE DRAINAGE FIELD DITCH (607)	+1	+1	-1	-1	-1	0	0	-1	-1
SURFACE DRAINAGE MAIN OR LATERAL (608)	+1	+1	-1	-1	-1	0	0	-1	-1
SURFACE ROUGHENING (609)	0	0	0	0	0	0	+/-	+/1	NA
TERRACES (GRADIENT) (600G)	0	0	+1	+1	+1	+2	+2	+1	0
TERRACES (STORAGE) (600S)	0	0	+/-	+/-	-1	+2	+2	+1	0
TREE / SHRUB PLANTING (612)	+1	+1	+1	+1	+1	+1	+1	+1	+1
TROUGH OR TANK (614)	0	0	+1	+1	NA	0	0	+1	+1
UNDERGROUND OUTLETS (620)	NA	NA	+2/-2	+2/-2	+2/-1	0	0	+1	0
USE EXCLUSION (472)	+2	+1	+1	+1	+1	+1	+1	+1	+1
VERTICAL DRAIN (630)	0	0	+1	+1	+1	0	0	+1	0
WASTE MANAGEMENT SYSTEM (312)	+2	NA	+2	+2	NA	0	0	+1	+1
WASTE STORAGE POND (425)	NA	NA	+2	+2	NA	NA	NA	+1	+1
WASTE STORAGE STRUCTURE (313)	NA	NA	+2	+2	NA	NA	NA	+1	+1
WASTE TREATMENT LAGOON (359)	NA	NA	+2	+2	NA	NA	NA	+1	+1
WASTE UTILIZATION (633)	+1	NA	+2	+2	NA	0	0	+1	+1
WATER AND SEDIMENT CONTROL BASIN (638)	0	0	-1/+1	-1/+1	-1/+1	+2	+2	+2	+1
WELL (IRRIGATION) (642I)	NA	NA	0	0	0	0	0	0	0

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL TILTH, CRUSTING, WATER INFILTRATION, ORGANIC MATERIALS	SOIL COMPACTION	SOIL CONTAMINANTS			DAMAGE ONSITE	DAMAGE OFFSITE	SUSPENDED SEDIMENT AND TURBIDITY	AQUATIC HABITAT SUITABILITY
			OTHER EXCESS ANIMAL MANURES AND ORGANIC	EXCESS FERTILIZERS	EXCESS PESTICIDES				
WELL (LIVESTOCK AND WILDLIFE) (642L)	NA	NA	0	0	0	0	0	0	0
WETLAND RESTORATION (INTERIM) (657)	+/-	NA	+2	+2	+2	0	0	+2	+2
WILDLIFE UPLAND HABITAT MANAGEMENT (645)	+2	+2	+2	+2	+2	0	0	+2	+1
WILDLIFE WATER FACILITY (648)	NA	NA	0	0	0	0	0	0	0
WILDLIFE WETLAND HABITAT MANAGEMENT (644)	+2	+2	+2	+2	+2	+2	0	0	+2
WINDBREAK/SHELTERBELT ESTABLISHMENT (380)	0	+1	+1	+1	+1	NA	NA	+1	+1
WOODLAND IMPROVED HARVEST (FINAL) (654F)	+1	+1	NA	NA	NA	+1	+1	+/-	NA
WOODLAND IMPROVED HARVEST (INTERMEDIATE THIN) (654I)	+1	+1	NA	NA	NA	+1	+1	+/-	+/-
WOODLAND PRUNING (660)	NA	NA	NA	NA	NA	NA	NA	NA	NA
WOODLAND SITE PREPARATION (490)	+/-	+/-	+/-	+/-	+/-	0	-1	-1	-1
WOODY ROOT PRUNING (INTERIM) (747)	0	NA	+/-	+/-	NA	0	0	+/-	NA

Note: The Conservation Practice Effects for Underground Outlets (620) depends on where the tile outlets: directly into a stream or onto vegetation.

TABLE 6: Nonpoint SOURCE WATER QUALITY IMPACTS DERIVED FROM NUTRIENT MANAGEMENT PRACTICES APPLIED TO AGRICULTURAL LANDS (11/03)

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL CONTAMINANTS		GROUND WATER CONTAMINANTS	SURFACE WATER CONTAMINANTS		AQUATIC HABITAT SUITABILITY
	EXCESS ANIMAL MANURES AND OTHER ORGANICS	EXCESS FERTILIZERS	NUTRIENTS AND ORGANICS	NUTRIENTS AND ORGANICS	LOW DISSOLVED OXYGEN	
ACCESS ROAD (560)	0	0	+1	+1	0	+1
CHISELING AND SUB-SOILING (324A)	+/-	+/-	-1	+1	+1	+1
CHISELING AND SUB-SOILING (324B)	+/-	+/-	-1	-1/+1	-1/+1	+1
CLEARING AND SNAGGING (326)	0	0	0	0	0	-1
COMMERCIAL FISHPONDS (397)	+1	+1	+2	+1	+1	+1
CONSERVATION COVER (327)	+1	+1	+1	+1	+1	+1
CONSERVATION CROP ROTATION (328)	+2	+2	+1	+1	+1	+1
CONTOUR BUFFER STRIP (332)	+1	+1	+1	+2	+1	+2
CONTOUR FARMING (330)	+1	+1	+1	+1	0	0
COVER AND GREEN MANURE CROP (340)	+2	+2	+1	+1	0	+1
CRITICAL AREA PLANTING (342)	+1	+1	+1	+1	0	+1

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL CONTAMINANTS		GROUND WATER CONTAMINANTS	SURFACE WATER CONTAMINANTS		AQUATIC HABITAT SUITABILITY
	EXCESS ANIMAL MANURES AND OTHER ORGANICS	EXCESS FERTILIZERS	NUTRIENTS AND ORGANICS	NUTRIENTS AND ORGANICS	LOW DISSOLVED OXYGEN	
CROSS WIND RIDGES (589A)	+1	+1	+1	+1	0	+1
CROSS WIND STRIP CROP (589B)	+1	+1	+1	+1	+1	+1
CROSS WIND TRAP STRIP (589C)	+1	+1	+1	+1	+1	+1
DAM, DIVERSION (348)	0	0	0	+1	+1	0
DAM, FLOODWATER RETARDING (402)	0	0	+1	+1	+1	+1
DAM, MULTIPLE PURPOSE (349)	0	0	0	+1	+1	+1
DEFERRED GRAZING (352)	+2	+2	+2	+1	+1	+1
DEEP TILLAGE (INTERIM) (XXX)	+1	+1	+1	+1	+1	NA
DIKE (EARTHEN) (356)	0	0	0	+1	+1	+1
DIVERSION (362)	0	0	0	+1	+1	0
FENCING (382)	+1	+1	+1	+1	+1	+1
FIELD BORDER (386)	+1	+1	NA	+1	NA	+1
FIELD WINDBREAK (392)	+1	+1	+1	+1	+1	+1
FILTER STRIP (393)	0	0	+1	+1	+1	+2
FISHPOND MANAGEMENT (399)	NA	NA	0	+1	0	0

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL CONTAMINANTS		GROUND WATER CONTAMINANTS	SURFACE WATER CONTAMINANTS		AQUATIC HABITAT SUITABILITY
	EXCESS ANIMAL MANURES AND OTHER ORGANICS	EXCESS FERTILIZERS	NUTRIENTS AND ORGANICS	NUTRIENTS AND ORGANICS	LOW DISSOLVED OXYGEN	
GRADE STABILIZATION STRUCTURE (410)	NA	NA	0	0	0	0
GRASSED WATERWAY (412)	0	0	0	0	0	0
GRASSES AND LEGUMES (ROTATION) (411)	+2	+2	+2	+1	+1	+1
HEAVY USE AREA PROTECTION (561)	NA	NA	0	+1	+1	+1
HEDGEROW PLANTING (422)	+1	+1	+1	+1	NA	+1
HERBACEOUS WIND BARRIERS (422A)	+1	+1	+1	+1	+1	+1
IRRIGATION FIELD DITCH (388)	+1	+1	0	-1	0	0
IRRIGATION LAND LEVELING (464)	0	0	+1	+1	0	0
IRRIGATION PIT OR REGULATING RESERVOIR (552)	+1	+1	+1	+1	+1	0
IRRIGATION STORAGE RESERVOIR (436)	+1	+1	+1	+1	+1	0
IRRIGATION SYSTEM - TRICKLE (MICRO) (441)	-1	-1	+1	+2	0	0
IRRIGATION SYSTEM –	0	0	+1	+1	+1	0

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL CONTAMINANTS		GROUND WATER CONTAMINANTS	SURFACE WATER CONTAMINANTS		AQUATIC HABITAT SUITABILITY
	EXCESS ANIMAL MANURES AND OTHER ORGANICS	EXCESS FERTILIZERS	NUTRIENTS AND ORGANICS	NUTRIENTS AND ORGANICS	LOW DISSOLVED OXYGEN	
SPRINKLER (442)						
IRRIGATION SYSTEM - SURFACE AND SUBSURFACE (443)	0	0	+2	+2	+1	-1
IRRIGATION SYSTEM - TAILWATER RECOVERY (447)	-1	-1	+/-	+1	+1	+1
IRRIGATION WATER CONVEYANCE - DITCH (428)	NA	NA	0	0	-1	0
IRRIGATION WATER CONVEYANCE -PIPELINE (430)	NA	NA	0	0	0	0
IRRIGATION WATER MANAGEMENT (449)	+2	+2	+2	+2	0	+1
LAND RECONSTRUCTION (ABANDONED MINE LAND) (543)	NA	NA	0	+1	0	0
LAND RECONSTRUCTION (CURRENT MINE LAND) (544)	NA	NA	0	0	+1	+1
LAND SMOOTHING (466)	+1	+1	+1	+/-	0	0
LINED WATERWAY OR OUTLET (468)	0	0	0	0	0	0
MULCHING (484)	+1	+1	+1	+1	+1	+1

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL CONTAMINANTS		GROUND WATER CONTAMINANTS	SURFACE WATER CONTAMINANTS		AQUATIC HABITAT SUITABILITY
	EXCESS ANIMAL MANURES AND OTHER ORGANICS	EXCESS FERTILIZERS	NUTRIENTS AND ORGANICS	NUTRIENTS AND ORGANICS	LOW DISSOLVED OXYGEN	
NUTRIENT MANAGEMENT (DEFICIT) (590D)	+2	+2	+2	+2	+1	+1
NUTRIENT MANAGEMENT (EXCESS) (590E)	+2	+2	+/-	+/-	+1	+1
OPEN CHANNEL (582)	NA	NA	0	0	+1	-1
PASTURE AND HAYLAND MANAGEMENT (510)	+1	+1	+1	+1	+1	0
PASTURE AND HAYLAND PLANTING (512)	+1	+1	+1	+1	+1	0
PLANNED GRAZING SYSTEM (556)	+1	+1	0	+1	+1	+1
POND (378)	NA	NA	+/-	0	0	0
POND SEALING OR LINING (521)	0	0	+1	0	0	0
POULTRY COMPOSTING FACILITY (313A)	+2	+1	0	+2	+2	+2
PRECISION LAND FORMING (462)	+1	+1	+1	+/-	0	0
PRESCRIBED BURNING (338)	0	0	0	+/-	-1 +/-	-1 +/-
PROPER GRAZING USE (528)	+1	+1	0	+1	+1	+1
PROPER WOODLAND GRAZING						

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL CONTAMINANTS		GROUND WATER CONTAMINANTS	SURFACE WATER CONTAMINANTS		AQUATIC HABITAT SUITABILITY
	EXCESS ANIMAL MANURES AND OTHER ORGANICS	EXCESS FERTILIZERS	NUTRIENTS AND ORGANICS	NUTRIENTS AND ORGANICS	LOW DISSOLVED OXYGEN	
(530)	0	0	0	0	0	0
PUMPING PLANT FOR WATER CONTROL (533)	+1	+1	+2	0	0	0
RESIDUE MANAGEMENT (NO TILL/ STRIP) (329A)	+1	+1	+1	+1	+1	+1
RESIDUE MANAGEMENT (MULCH TILL) (329B)	+1	+1	+1	+1	+1	+1
RESIDUE MANAGEMENT (RIDGE TILL) (329R)	+1	+1	+1	+1	+1	+1
RESIDUE MANAGEMENT (SEASONAL) (344)	+1	+1	+1	+1	+1	+1
RIPARIAN FOREST BUFFER (391)	+1	+1	+2	+2	+2	+2
ROW ARRANGEMENT (557)	+1	+1	+1	+1	+1	+1
RUNOFF MANAGEMENT SYSTEM (570)	NA	NA	0	+1	0	0
SEDIMENT BASIN (350)	0	0	0	+1	+1	0
SINKHOLE TREATMENT (INTERIM) (725)	+1	+1	+2	+1	+1	+1
SPOIL SPREADING (572)	0	0	+1	0	0	0

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL CONTAMINANTS		GROUND WATER CONTAMINANTS	SURFACE WATER CONTAMINANTS		AQUATIC HABITAT SUITABILITY
	EXCESS ANIMAL MANURES AND OTHER ORGANICS	EXCESS FERTILIZERS	NUTRIENTS AND ORGANICS	NUTRIENTS AND ORGANICS	LOW DISSOLVED OXYGEN	
SPRING DEVELOPMENT (574)	0	0	0	+1	0	0
STREAMBANK AND SHORELINE PROTECTION (580)	NA	NA	0	+1	+1	+1
STREAM CHANNEL STABILIZATION (584)	0	0	0	+1	+1	+1
STRIPCROPPING (CONTOUR) (585)	+1	+1	+2	+2	+1	+1
STRIPCROPPING (FIELD) (586)	+1	+1	+2	+2	+1	+1
STRUCTURE FOR WATER CONTROL (587)	+1	+1	+/-	+1	+1	+2
SUBSURFACE DRAIN (606)	+1	+1	+1	-1/+1	0	-1/-2
SURFACE DRAINAGE FIELD DITCH (607)	+1	+1	0	-1	-1	-1
SURFACE DRAINAGE MAIN OR LATERAL (608)	+1	+1	0	-1	-1	-1
SURFACE ROUGHENING (609)	0	0	0	+2	+1	+1
TERRACES (GRADIENT) (600G)	+1	+1	0	+1	+1	0
TERRACES (STORAGE) (600S)	+1	+1	0	-1/+1	+1	0

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL CONTAMINANTS		GROUND WATER CONTAMINANTS	SURFACE WATER CONTAMINANTS		AQUATIC HABITAT SUITABILITY
	EXCESS ANIMAL MANURES AND OTHER ORGANICS	EXCESS FERTILIZERS	NUTRIENTS AND ORGANICS	NUTRIENTS AND ORGANICS	LOW DISSOLVED OXYGEN	
TREE / SHRUB PLANTING (612)	+1	+1	+1	+1	+1	+1
UNDERGROUND OUTLETS (620)	0	0	0	-1/+1	0	0
USE EXCLUSION (472)	+2	+2	+2	+1	+1	+1
VERTICAL DRAIN (630)	0	0	0	-1/+1	0	0
WASTE MANAGEMENT SYSTEM (312)	+2	+2	+2	+2	+1	+1
WASTE STORAGE POND (425)	+2	+2	+2	+2	+1	+1
WASTE STORAGE STRUCTURE (313)	+2	+2	+2	+2	+1	+1
WASTE TREATMENT LAGOON (359)	+2	+2	+2	+2	+1	+1
WASTE UTILIZATION (633)	+2	+2	+2	+2	+1	+2
WATER AND SEDIMENT CONTROL BASIN (638)	0	0	-1	-2/+2	+2	+1
WELL (IRRIGATION) (642i)	+1	+1	0	0	0	+1
WETLAND RESTORATION (INTERIM) (657)	NA	NA	+1	+2	+2	+2
WILDLIFE UPLAND HABITAT						

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL CONTAMINANTS		GROUND WATER CONTAMINANTS	SURFACE WATER CONTAMINANTS		AQUATIC HABITAT SUITABILITY
	EXCESS ANIMAL MANURES AND OTHER ORGANICS	EXCESS FERTILIZERS	NUTRIENTS AND ORGANICS	NUTRIENTS AND ORGANICS	LOW DISSOLVED OXYGEN	
MANAGEMENT (645)	0	0	+1	+2	+2	+1
WILDLIFE WETLAND HABITAT MANAGEMENT (644)	NA	NA	+1	+2	+2	+2
WINDBREAK/SHELTERBELT ESTABLISHMENT RENOVATION (380)	+1	+1	+1	+1	NA	+1
WOODLAND IMPROVED HARVEST (FINAL) (654F)	NA	NA	0	-1	-1	-1
WOODLAND IMPROVED HARVEST (INTERMEDIATE THIN) (654I)	NA	NA	0	-1	-1	-1
WOODLAND SITE PREPARATION (490)	NA	NA	0	+/-	-1	-1
WOODY ROOT PRUNING (INTERIM) (747)	NA	NA	0	0	0	0

THE FOLLOWING CONSERVATION PRACTICES ARE NOT APPLICABLE TO NUTRIENT MANAGEMENT AND NONPOINT SOURCE WATER QUALITY IMPACTS.

BRUSH MANAGEMENT (BIOLOGICAL) (314B)
BRUSH MANAGEMENT (CHEMICAL) (314C)
BRUSH MANAGEMENT (MECHANICAL) (314M)
BRUSH MANAGEMENT (BURNING) (314F)

PEST MANAGEMENT (MECHANICAL) (595M)
PIPELINE (516)
RECREATION AREA IMPROVEMENT (562)
RECREATION LAND GRADING AND SHAPING (566)

FIREBREAK (394)
TROUGH OR TANK (614)
FOREST STAND IMPROVEMENT (666)
OBSTRUCTION REMOVAL (500)
PEST MANAGEMENT (BIOLOGICAL) (595B)
PEST MANAGEMENT (CHEMICAL) (595C)

RECREATION TRAIL AND WALKWAY (568)
WELL (LIVESTOCK AND WILDLIFE) (642L)
WILDLIFE WATER FACILITY (648)
WOODLAND PRUNING (660)

TABLE 7: NONPOINT SOURCE WATER QUALITY IMPACTS DERIVED FROM PESTICIDE MANAGEMENT PRACTICES APPLIED ON AGRICULTURAL LANDS 11/03

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL CONTAMINANTS	GROUND WATER CONTAMINANTS	SURFACE WATER CONTAMINANTS	AQUATIC HABITAT SUITABILITY
	EXCESS PESTICIDES	PESTICIDES	PESTICIDES	
ACCESS ROAD (560)	0	+1	+1	+1
BRUSH MANAGEMENT (BIOLOGICAL) (314B)	NA	+2	+2	0
BRUSH MANAGEMENT (CHEMICAL) (314C)	NA	+/-	+/-	+/-
BRUSH MANAGEMENT (MECHANICAL) (314M)	NA	+1	+1	0
BRUSH MANAGEMENT (BURNING) (314F)	NA	0	0	0
CHISELING AND SUB-SOILING (324A)	+1	+1	+1	0
CHISELING AND SUB-SOILING (324B)	+1	+1	+1	0
CONSERVATION COVER (327)	+1	+1	+1	+1
CONSERVATION CROP ROTATION (328)	+2-	+1	+1	+1
CONTOUR BUFFER STRIP (332)	+1	+1	+1	+2
CONTOUR FARMING (330)	+1	+1	+1	0
COVER AND GREEN MANURE CROP (340)	+2	+1	+1	+1
CRITICAL AREA PLANTING (342)	+1	+1	+1	+1

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL CONTAMINANTS	GROUND WATER CONTAMINANTS	SURFACE WATER CONTAMINANTS	AQUATIC HABITAT SUITABILITY
	EXCESS PESTICIDES	PESTICIDES	PESTICIDES	
CROSS WIND RIDGES (589A)	+1	+1	+1	+1
CROSS WIND STRIP CROP (589B)	+1	+1	+2	+1
CROSS WIND TRAP STRIP (589C)	+1	+1	+1	+1
DEFERRED GRAZING (352)	+2	+2	+1	+1
DEEP TILLAGE (INTERIM) (XXX)	+1	+1	+1	0
DIKE (EARTHEN) (356)	0	0	+1	+1
DIVERSION (362)	0	-1	+1	0
FARMSTEAD AND EVALUATION (INTERIM) (752)	+1	+1	+1	0
FIELD BORDER (386)	+1	NA	+1	+1
FILTER STRIP (393)	0	+1	+1	+2
GRADE STABILIZATION STRUCTURE (410)	NA	0	0	0
GRASSED WATERWAY (412)	0	0	+/-	0
GRASSES AND LEGUMES (ROTATION) (411)	+1	+1	+1	+1
HERBACEOUS WIND BARRIERS (422A)	+1	+1	+1	+1
IRRIGATION FIELD DITCH (388)	+1	0	-1	0
IRRIGATION LAND LEVELING (464)	0	+1	+1	0

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL CONTAMINANTS	GROUND WATER CONTAMINANTS	SURFACE WATER CONTAMINANTS	AQUATIC HABITAT SUITABILITY
	EXCESS PESTICIDES	PESTICIDES	PESTICIDES	
IRRIGATION PIT OR REGULATING RESERVOIR (552)	+1	+1	+1	0
IRRIGATION SYSTEM - TRICKLE (MICRO) (441)	-1	+1	+1	0
IRRIGATION SYSTEM - SPRINKLER (442)	0	+1	+1	0
IRRIGATION SYSTEM - SURFACE AND SUBSURFACE (443)	0	+1	+1	-1
IRRIGATION SYSTEM -TAILWATER RECOVERY (447)	-1	-1	+1	+1
IRRIGATION WATER CONVEYANCE - DITCH (428)	NA	0	0	0
IRRIGATION WATER CONVEYANCE - PIPELINE (430)	NA	0	0	0
IRRIGATION WATER MANAGEMENT (449)	+2	+2	+1	+1
LAND SMOOTHING (466)	0	+1	+/-	0
LINED WATERWAY OR OUTLET (468)	0	0	0	0
MULCHING (484)	+1	+1	+1	+1
PASTURE AND HAYLAND MANAGEMENT (510)	+1	0	+1	0
PASTURE AND HAYLAND PLANTING	+2	+1	+1	+1

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL CONTAMINANTS	GROUND WATER CONTAMINANTS	SURFACE WATER CONTAMINANTS	AQUATIC HABITAT SUITABILITY
	EXCESS PESTICIDES	PESTICIDES	PESTICIDES	
(512)				
PEST MANAGEMENT (BIOLOGICAL) (595B)	+2	+2	+2	0
PEST MANAGEMENT (CHEMICAL) (595C)	+/-	+1	+2	NA
PEST MANAGEMENT (MECHANICAL) (595M)	+2	+2	+2	0
PLANNED GRAZING SYSTEM (556)	+1	+1	+1	-1
POND (378)	NA	+/-	-1	0
PRECISION LAND FORMING (462)	0	+1	-1	0
PRESCRIBED BURNING (338)	+2	0	+1	-1
PROPER GRAZING USE (528)	+1	+1	+1	0
PUMPING PLANT FOR WATER CONTROL (533)	+1	+2	0	0
RESIDUE MANAGEMENT (NO TILL/ STRIP) (329A)	+1	+1	+1	+1
RESIDUE MANAGEMENT (MULCH TILL) (329B)	+1	+1	+1	+1
RESIDUE MANAGEMENT (RIDGE TILL) (329R)	+1	+1	+1	+1
RESIDUE MANAGEMENT (SEASONAL)				

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL CONTAMINANTS	GROUND WATER CONTAMINANTS	SURFACE WATER CONTAMINANTS	AQUATIC HABITAT SUITABILITY
	EXCESS PESTICIDES	PESTICIDES	PESTICIDES	
(344)	+1	+1	+1	+1
RIPARIAN FOREST BUFFER (391)	+1	+2	+2	+2
ROW ARRANGEMENT (557)	+1	+1	+1	0
RUNOFF MANAGEMENT SYSTEM (570)	NA	0	+1	0
SEDIMENT BASIN (350)	0	0	+1	0
SINKHOLE TREATMENT (INTERIM) (725)	+1	+1	-1/+1	+1
STREAMBANK AND SHORELINE PROTECTION (580)	NA	0	+1	+1
STRIPCROPPING (CONTOUR) (585)	+1	+2	+2	+1
STRIPCROPPING (FIELD) (586)	+1	+2	+2	+1
STRUCTURE FOR WATER CONTROL (587)	+1	+1	+1	+2
SUBSURFACE DRAIN (606)	+1	+1	-1/+1	-1/-2
SURFACE DRAINAGE FIELD DITCH (607)	0	0	-1	-1
SURFACE DRAINAGE MAIN OR LATERAL (608)	0	0	-1	-1
SURFACE ROUGHENING (609)	+1	+1	+1	0
TERRACES (GRADIENT) (600G)	0	+/-	+1	0

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL CONTAMINANTS	GROUND WATER CONTAMINANTS	SURFACE WATER CONTAMINANTS	AQUATIC HABITAT SUITABILITY
	EXCESS PESTICIDES	PESTICIDES	PESTICIDES	
TERRACES (STORAGE) (600S)	-1	+/-	+/-	0
UNDERGROUND OUTLETS (620) *	-1	+/-	-1/-2	0
USE EXCLUSION (472)	+2	+2	+1	+1
VERTICAL DRAIN (630)	0	+/-	-1/-2	0
WATER AND SEDIMENT CONTROL BASIN (638)	0	+/-	+1	+1
WELL (IRRIGATION) (642i)	+1	0	0	+1
WETLAND RESTORATION (INTERIM) (657)	NA	+1	+2	+1
WILDLIFE UPLAND HABITAT MANAGEMENT (645)	0	+1	+2	+1

THE FOLLOWING CONSERVATION PRACTICES DO NOT HAVE APPLICABILITY TO NONPOINT SOURCE WATER QUALITY IMPACTS RESULTING FROM PESTICIDE MANAGEMENT.

CLEARING AND SNAGGING (326)

COMMERCIAL FISHPONDS (397)

DAM, DIVERSION (348)

DAM, FLOODWATER RETARDING (402)

DAM, MULTIPLE PURPOSE (349)

FENCING (382)

FIELD WINDBREAK (392)

FIREBREAK (394)

FISHPOND MANAGEMENT (399)

FOREST STAND IMPROVEMENT (666)

HEAVY USE AREA PROTECTION (561)

HEDGEROW PLANTING (422)

IRRIGATION STORAGE RESERVOIR (436)

LAND RECONSTRUCTION (ABANDONED MINE LAND) (543)

LAND RECONSTRUCTION (CURRENT MINE LAND) (544)

NUTRIENT MANAGEMENT (DEFICIT) (590D)

NUTRIENT MANAGEMENT (EXCESS) (590E)

OBSTRUCTION REMOVAL (500)

OPEN CHANNEL (582)

PIPELINE (516)

POND SEALING OR LINING (521)

POULTRY COMPOSTING FACILITY (313A)

PROPER WOODLAND GRAZING (530)

RECREATION AREA IMPROVEMENT (562)

RECREATION LAND GRADING AND SHAPING (566)

RECREATION TRAIL AND WALKWAY (568)

SPOIL SPREADING (572)

SPRING DEVELOPMENT (574)

STREAM CHANNEL STABILIZATION (584)

TREE / SHRUB PLANTING (612)

TROUGH OR TANK (614)

WASTE MANAGEMENT SYSTEM (312)

WASTE STORAGE POND (425)

WASTE STORAGE STRUCTURE (313)

WASTE TREATMENT LAGOON (359)

WASTE UTILIZATION (633)

WELL (LIVESTOCK AND WILDLIFE) (642L)

WILDLIFE WATER FACILITY (648)

WINDBREAK/SHELTERBELT ESTABLISHMENT (380)

WOODLAND IMPROVED HARVEST (FINAL) (654F)

WOODLAND PRUNING (660)

WILDLIFE WETLAND HABITAT MANAGEMENT (644)

WOODLAND SITE PREPARATION (490)

Note: The Conservation Practice Effects for Underground Outlets (620) depends on where the tile outlets: directly into a stream or onto vegetation.

TABLE 8: NONPOINT SOURCE WATER QUALITY IMPACTS DERIVED FROM IRRIGATION MANAGEMENT PRACTICES APPLIED TO AGRICULTURAL LANDS (12/28/98)

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL TILTH, CRUSTING, WATER INFILTRATION, ORGANIC MATERIALS	SOIL COMPACTION	SOIL CONTAMINANTS	GROUNDWATER CONTAMINANTS		SURFACE WATER CONTAMINANTS		SUSPENDED SEDIMENT AND TURBIDITY	WATER MANAGEMENT IRRIGATED LANDS
			EXCESS ANIMAL MANURES AND OTHER ORGANICS	NUTRIENTS AND ORGANICS	PESTICIDES	NUTRIENTS AND ORGANICS	PESTICIDES		
ACCESS ROAD (560)	NA	+1	+2	+1	+1	+1	+1	+1	+1
CHISELING AND SUB-SOILING (324A)	+1	+1	+1	+1	+1	+1	+1	+1	0
CHISELING AND SUB-SOILING (324B)	+1	+1	+1	+1	+1	+1	+1	+1	0
CONSERVATION COVER (327)	+1	+1	+1	+1	+1	+1	+1	+1	0
CONSERVATION CROP ROTATION (328)	+2	+2	+1	+1	+1	+1	+1	+1	+1
COVER AND GREEN MANURE CROP (340)	+2	+2	+1	+1	+1	+1	+1	+1	+1
CRITICAL AREA PLANTING (342)	+2	+2	+1	+1	+1	+1	+1	+1	+1
CROSS WIND RIDGES (589A)	+1	+1	+1	+1	+1	+1	+2	+1	+1
CROSS WIND STRIP CROP (589B)	+2	+1	+1	+1	+1	+1	+1	+1	+1
CROSS WIND TRAP STRIP (589C)	+1	+1	+1	+1	+1	+1	+1	+1	+1

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL TILTH, CRUSTING, WATER INFILTRATION, ORGANIC MATERIALS	SOIL COMPACTION	SOIL CONTAMINANTS	GROUNDWATER CONTAMINANTS		SURFACE WATER CONTAMINANTS		SUSPENDED SEDIMENT AND TURBIDITY	WATER MANAGEMENT IRRIGATED LANDS
			EXCESS ANIMAL MANURES AND OTHER ORGANICS	NUTRIENTS AND ORGANICS	PESTICIDES	NUTRIENTS AND ORGANICS	PESTICIDES		
DEEP TILLAGE (INTERIM) (XXX)	+1	+1	+1	+1	+1	+1	+1	+1	+1
DIKE (EARTHEN) (356)	0	0	0	0	0	+1	+1	+1	NA
DIVERSION (362)	0	0	-1	-1	-1	+1	+1	+1	+2
FIELD BORDER (386)	+1	+1	NA	NA	NA	+1	+1	0	NA
FIELD WINDBREAK (392)	0	0	+1	+1	+1	+1	+1	+1	+1
FILTER STRIP (393)	0	0	+1	+1	+1	+1	+1	+2	NA
GRADE STABILIZATION STRUCTURE (410)	NA	NA	0	0	0	+1	+1	+1	NA
GRASSED WATERWAY (412)	0	0	0	-1	0	+1	+1	+1	NA
GRASSES AND LEGUMES (ROTATION) (411)	+2	+2	+2	+2	+2	+2	+2	+2	+2
HEAVY USE AREA PROTECTION (561)	+1	+1	0	0	0	+1	+1	+2	NA
HEDGEROW PLANTING (422)	0	+1	+1	+1	+1	+1	+1	+1	+1
HERBACEOUS WIND BARRIERS (422A)	+1	+1	+1	+1	+1	+1	+1	+1	+1
IRRIGATION FIELD DITCH (388)	0	0	0	0	0	-1	-1	0	+/-

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL TILTH, CRUSTING, WATER INFILTRATION, ORGANIC MATERIALS	SOIL COMPACTION	SOIL CONTAMINANTS	GROUNDWATER CONTAMINANTS		SURFACE WATER CONTAMINANTS		SUSPENDED SEDIMENT AND TURBIDITY	WATER MANAGEMENT IRRIGATED LANDS
			EXCESS ANIMAL MANURES AND OTHER ORGANICS	NUTRIENTS AND ORGANICS	PESTICIDES	NUTRIENTS AND ORGANICS	PESTICIDES		
IRRIGATION LAND LEVELING (464)	0	+/-	+1	+1	+1	+1	+1	+1	+2
IRRIGATION PIT OR REGULATING RESERVOIR (552)	0	0	+1	+1	+1	+1	+1	+1	+2
IRRIGATION STORAGE RESERVOIR (436)	0	0	+1	+1	+1	+1	+1	+1	+2
IRRIGATION SYSTEM - TRICKLE (MICRO) (441)	+1	+1	+2	+2	+2	+2	+1	+1	+1
IRRIGATION SYSTEM – SPRINKLER (442)	-1	+1	+1	+1	+1	+1	+1	+2	-2
IRRIGATION SYSTEM – SURFACE AND SUBSURFACE (443)	0	-2	+1	+1	+1	+1	+1	+1	+1
IRRIGATION SYSTEM -TAIL WATER RECOVERY (447)	0	0	-1	-1	-1	+/-	+/-	+1	+1
IRRIGATION WATER CONVEYANCE - DITCH (428)	0	NA	NA	0	0	0	0	0	NA
IRRIGATION WATER CONVEYANCE - PIPELINE (430)	0	NA	NA	0	0	0	0	0	NA
IRRIGATION WATER MANAGEMENT (449)	+2	+1	+2	+2	+2	+2	+2	+2	+2

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL TILTH, CRUSTING, WATER INFILTRATION, ORGANIC MATERIALS	SOIL COMPACTION	SOIL CONTAMINANTS	GROUNDWATER CONTAMINANTS		SURFACE WATER CONTAMINANTS		SUSPENDED SEDIMENT AND TURBIDITY	WATER MANAGEMENT IRRIGATED LANDS
			EXCESS ANIMAL MANURES AND OTHER ORGANICS	NUTRIENTS AND ORGANICS	PESTICIDES	NUTRIENTS AND ORGANICS	PESTICIDES		
LAND SMOOTHING (466)	0	0	+1	+1	-1	-1/+1	-1/+1	-1/+1	+1
LINED WATERWAY OR OUTLET (468)	NA	NA	0	0	0	0	0	0	0
NUTRIENT MANAGEMENT (DEFICIT) (590D)	+1	NA	NA	+1	NA	+1	NA	0	+1
NUTRIENT MANAGEMENT (EXCESS) (590E)	+1	NA	+2	+2	NA	+2	NA	+1	+1
OBSTRUCTION REMOVAL (500)	0	0	0	0	0	0	0	0	0
OPEN CHANNEL (582)	NA	NA	0	0	0	0	0	0	NA
PEST MANAGEMENT (BIOLOGICAL) (595B)	NA	NA	NA	NA	+1	NA	+1	0	NA
PEST MANAGEMENT (CHEMICAL) (595C)	NA	NA	NA	NA	+1	NA	+1	0	NA
PEST MANAGEMENT (MECHANICAL) (595M)	NA	NA	NA	NA	+1	NA	+1	0	NA
PIPELINE (516)	0	0	NA	NA	NA	NA	NA	NA	NA
POND (378)	NA	0	NA	+/-	+/-	-1	-1	0	NA
POND SEALING OR LINING (521)	+1	+1	NA	+1	+1	0	0	0	+1
PRECISION LAND FORMING (462)	0	0	+1	+1	+1	+/-	+/-	0	+1

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL TILTH, CRUSTING, WATER INFILTRATION, ORGANIC MATERIALS	SOIL COMPACTION	SOIL CONTAMINANTS	GROUNDWATER CONTAMINANTS		SURFACE WATER CONTAMINANTS		SUSPENDED SEDIMENT AND TURBIDITY	WATER MANAGEMENT IRRIGATED LANDS
			EXCESS ANIMAL MANURES AND OTHER ORGANICS	NUTRIENTS AND ORGANICS	PESTICIDES	NUTRIENTS AND ORGANICS	PESTICIDES		
PUMPING PLANT FOR WATER CONTROL (533)	0	0	+2	+2	+2	0	0	0	+1
RESIDUE MANAGEMENT (NO TILL/ STRIP) (329A)	+2	+2	+1	+1	+1	+1	+1	+1	+1
RESIDUE MANAGEMENT (MULCH TILL) (329B)	+2	+1	+1	+1	+1	+1	+1	+1	+2
RESIDUE MANAGEMENT (RIDGE TILL) (329R)	+2	+1	+1	+1	+1	+1	+1	+1	+1
RESIDUE MANAGEMENT (SEASONAL) (344)	+2	+1	+1	+1	+1	+1	+1	+1	+1
RIPARIAN FOREST BUFFER (391)	+1	+1	+2	+2	+2	+2	+2	+2	NA
ROW ARRANGEMENT (557)	+1	+2	+1	+2	0	+2	+1	+1	+1
RUNOFF MANAGEMENT SYSTEM (570)	+1	-1	0	0	0	+1	+1	+2	+1
SEDIMENT BASIN (350)	0	0	0	0	0	+1	+1	+2	0
STREAM BANK AND SHORELINE PROTECTION (580)	0	0	0	0	0	+1	+1	+1	NA
STREAM CHANNEL STABILIZATION (584)	0	0	0	0	0	+1	+1	+1	0
STRIP CROPPING (FIELD)									

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL TILTH, CRUSTING, WATER INFILTRATION, ORGANIC MATERIALS	SOIL COMPACTION	SOIL CONTAMINANTS	GROUNDWATER CONTAMINANTS		SURFACE WATER CONTAMINANTS		SUSPENDED SEDIMENT AND TURBIDITY	WATER MANAGEMENT IRRIGATED LANDS
			EXCESS ANIMAL MANURES AND OTHER ORGANICS	NUTRIENTS AND ORGANICS	PESTICIDES	NUTRIENTS AND ORGANICS	PESTICIDES		
(586)	+2	+1	+2	+2	+2	+2	+2	+1	0
STRUCTURE FOR WATER CONTROL (587)	0	+1	+1	-1	+1	+1	+1	0	+1
SUBSURFACE DRAIN (606)	+1	+1	+1	+1	+1	-1/+1	-1/+1	+1	+1
SURFACE DRAINAGE FIELD DITCH (607)	+1	+1	0	0	0	-1	-1	-1	+1
SURFACE DRAINAGE MAIN OR LATERAL (608)	+1	+1	0	0	0	-1	-1	-1	+1
SURFACE ROUGHENING (609)	0	0	0	0	0	+1	+1	+1	0
UNDERGROUND OUTLETS (620) *	NA	NA	0	0	0	-1/+1	-1/+1	+1	NA
VERTICAL DRAIN (630)	0	0	0	0	0	-1/+1	-1/+1	+1	NA
WASTE MANAGEMENT SYSTEM (312)	+1	NA	+2	+2	NA	+2	NA	+1	+1
WASTE STORAGE POND (425)	NA	NA	+2	+2	NA	+2	NA	+2	NA
WASTE STORAGE STRUCTURE (313)	NA	NA	+2	+2	NA	+2	NA	+1	NA
WASTE TREATMENT	NA	NA	+2	+2	NA	+2	NA	+1	+1

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL TILTH, CRUSTING, WATER INFILTRATION, ORGANIC MATERIALS	SOIL COMPACTION	SOIL CONTAMINANTS	GROUNDWATER CONTAMINANTS		SURFACE WATER CONTAMINANTS		SUSPENDED SEDIMENT AND TURBIDITY	WATER MANAGEMENT IRRIGATED LANDS
			EXCESS ANIMAL MANURES AND OTHER ORGANICS	NUTRIENTS AND ORGANICS	PESTICIDES	NUTRIENTS AND ORGANICS	PESTICIDES		
LAGOON (359)									
WASTE UTILIZATION (633)	+1	NA	+2	+2	NA	+2	NA	+1	+1
WELL (IRRIGATION) (642I)	0	+1	0	0	0	0	0	0	+1
WILDLIFE UPLAND HABITAT MANAGEMENT (645)	+2	+2	+1	+1	+1	+2	+2	+2	NA
WILDLIFE WETLAND HABITAT MANAGEMENT (644)	NA	NA	+1	+1	+1	+2	+2	+2	+1

THE FOLLOWING CONSERVATION PRACTICES DO NOT HAVE APPLICABILITY TO NONPOINT SOURCE WATER QUALITY IMPACTS RESULTING FROM IRRIGATION MANAGEMENT.

BRUSH MANAGEMENT (BIOLOGICAL) (314B)	FOREST STAND IMPROVEMENT (666)	STRIP CROPPING (CONTOUR) (585)
BRUSH MANAGEMENT (CHEMICAL) (314C)		TERRACES (GRADIENT) (600G)
BRUSH MANAGEMENT (MECHANICAL) (314M)	LAND RECONSTRUCTION (ABANDONED MINE LAND) (543)	TERRACES (STORAGE) (600S)
BRUSH MANAGEMENT (BURNING) (314F)	LAND RECONSTRUCTION (CURRENT MINE LAND) (544)	TREE/SHRUB PLANTING (612)
CLEARING AND SNAGGING (326)	MULCHING (484)	TROUGH OR TANK (614)
COMMERCIAL FISH PONDS (397)	PASTURE AND HAYLAND MANAGEMENT (510)	USE EXCLUSION (472)
CONTOUR BUFFER STRIP (332)	PASTURE AND HAYLAND PLANTING (512)	WATER AND SEDIMENT CONTROL BASIN (638)
CONTOUR FARMING (330)	PLANNED GRAZING SYSTEM (556)	WELL (LIVESTOCK AND WILDLIFE) (642L)
DAM, DIVERSION (348)	POULTRY COMPOSTING FACILITY (313A)	WETLAND RESTORATION (INTERIM) (657)
DAM, FLOODWATER RETARDING (402)	PRESCRIBED BURNING (338)	WILDLIFE WATER FACILITY (648)
DAM, MULTIPLE PURPOSE (349)	PROPER GRAZING USE (528)	WINDBREAK/SHELTERBELT ESTABLISHMENT (380)
DEFERRED GRAZING (352)	PROPER WOODLAND GRAZING (530)	
	RECREATION AREA IMPROVEMENT (562)	WOODLAND IMPROVED HARVEST (FINAL) (654F)
FENCING (382)	RECREATION LAND GRADING AND SHAPING (566)	
FIREBREAK (394)	RECREATION TRAIL AND WALKWAY (568)	WOODLAND PRUNING (660)
FISHPOND MANAGEMENT (399)	SPOIL SPREADING (572)	WOODLAND SITE PREPARATION (490)
	SPRING DEVELOPMENT (574)	

Note: The Conservation Practice Effects for Underground Outlets (620) depends on where the tile outlets: directly into a stream or onto vegetation.

TABLE 9: NONPOINT SOURCE WATER QUALITY IMPACTS DERIVED FROM MANURE MANAGEMENT PRACTICES APPLIED TO AGRICULTURAL LANDS (11/03)

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL CONTAMINANTS	GROUND WATER CONTAMINANTS		SURFACE WATER CONTAMINANTS			SUSPENDED SEDIMENT AND TURBIDITY	AQUATIC HABITAT SUITABILITY
	EXCESS ANIMAL MANURES AND OTHER ORGANICS	NUTRIENTS AND ORGANICS	PATHOGENS	NUTRIENTS AND ORGANICS	LOW DISSOLVED OXYGEN	PATHOGENS		
ACCESS ROAD (560)	+2	+1	0	+1	0	0	+1	+1
CHISELING AND SUB-SOILING (324A)	+/-	-1	0	+1	+1	0	+1	+1
CHISELING AND SUB-SOILING (324B)	+/-	-1	0	+1	+1	0	+1	+1
COMMERCIAL FISH PONDS (397)	+1	+2	0	+1	+1	0	+1	+1
CONSERVATION COVER (327)	+2	+2	+1	+2	+1	0	+1	+1
CONSERVATION CROP ROTATION (328)	+1	+1	+1	+1	+1	0	+1	+1
CONTOUR BUFFER STRIP (332)	+1	+1	+1	+2	+1	+2	+2	+2
CONTOUR FARMING (330)	+1	+1	0	+1	0	0	+1	0
COVER AND GREEN MANURE CROP (340)	+2	+1	0	+1	0	0	+1	+1
CRITICAL AREA PLANTING (342)	+1	+1	NA	+1	+1	0	+2	+1
CROSS WIND RIDGES (589A)	+1	+1	0	+2	+1	0	+1	+2
CROSS WIND STRIP CROP (589A)	+1	+1	0	+1	+1	0	+1	+1

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL CONTAMINANTS	GROUND WATER CONTAMINANTS		SURFACE WATER CONTAMINANTS			SUSPENDED SEDIMENT AND TURBIDITY	AQUATIC HABITAT SUITABILITY
	EXCESS ANIMAL MANURES AND OTHER ORGANICS	NUTRIENTS AND ORGANICS	PATHOGENS	NUTRIENTS AND ORGANICS	LOW DISSOLVED OXYGEN	PATHOGENS		
CROSS WIND TRAP STRIP (589C)	+1	+1	0	+1	+1	0	+1	+1
DAM, DIVERSION (348)	0	0	0	+1	+1	0	+1	0
DAM, FLOODWATER RETARDING (402)	0	+1	+1	+1	+1	+1	+1	+1
DAM, MULTIPLE PURPOSE (349)	0	0	0	+1	+1	+1	+1	+1
DEFERRED GRAZING (352)	+2	+2	+1	0	+1	0	+1	+1
DEEP TILLAGE (INTERIM) (XXX)	+1	+1	-2	0	+1	0	+1	NA
DIKE (EARTHEN) (356)	0	0	+1	0	+1	+1	+1	+1
DIVERSION (362)	0	0	0	+/-	+1	+1	+1	0
FIELD BORDER (386)	+1	+1	+1	+1	+1	+1	0	+1
FIELD WINDBREAK (392)	+1	+1	0	+1	+1	0	0	+1
FILTER STRIP (393)	0	+1	0	+1	+1	0	+2	+2
FISHPOND MANAGEMENT (399)	NA	-1	0	-1	-1	0	+1	+2
GRADE STABILIZATION STRUCTURE (410)	0	0	0	0	0	0	+1	0
GRASSED WATERWAY (412)	0	0	0	+1	0	0	+1	0
GRASSES AND LEGUMES (ROTATION) (411)	+2	+2	+1	+1	+1	+1	+2	+1
HEAVY USE AREA PROTECTION								

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL CONTAMINANTS	GROUND WATER CONTAMINANTS		SURFACE WATER CONTAMINANTS			SUSPENDED SEDIMENT AND TURBIDITY	AQUATIC HABITAT SUITABILITY
	EXCESS ANIMAL MANURES AND OTHER ORGANICS	NUTRIENTS AND ORGANICS	PATHOGENS	NUTRIENTS AND ORGANICS	LOW DISSOLVED OXYGEN	PATHOGENS		
(561)	NA	+1	+1	+1	+1	+1	+2	+1
HEDGEROW PLANTING (422)	+1	+1	+1	+1	0	NA	+1	+1
HERBACEOUS WIND BARRIERS (422A)	+1	0	0	+1	+1	0	1+	+1
IRRIGATION FIELD DITCH (388)	+1	0	0	-1	0	0	0	0
IRRIGATION LAND LEVELING (464)	0	+1	-1	+1	+1	-1	+1	0
IRRIGATION PIT OR REGULATING RESERVOIR (552)	+1	+1	+1	+1	+1	0	+1A	0
IRRIGATION STORAGE RESERVOIR (436)	+1	+1	+1	+1	+1	0	+1	0
IRRIGATION SYSTEM - TRICKLE (MICRO) (441)	-1	+1	+1	+1	+1	+1	+1	0
IRRIGATION SYSTEM - SPRINKLER (442)	0	+1	0	+1	+1	-1	+2	0
IRRIGATION SYSTEM - SURFACE AND SUBSURFACE (443)	0	+1	0	+1	+1	+1	+1	-1
IRRIGATION SYSTEM - TAIL WATER RECOVERY (447)	-1	-1	-1	+1	+1	+1	+1	+1
IRRIGATION WATER CONVEYANCE - DITCH (428)	NA	0	0	0	0	0	0	0

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL CONTAMINANTS	GROUND WATER CONTAMINANTS		SURFACE WATER CONTAMINANTS			SUSPENDED SEDIMENT AND TURBIDITY	AQUATIC HABITAT SUITABILITY
	EXCESS ANIMAL MANURES AND OTHER ORGANICS	NUTRIENTS AND ORGANICS	PATHOGENS	NUTRIENTS AND ORGANICS	LOW DISSOLVED OXYGEN	PATHOGENS		
IRRIGATION WATER CONVEYANCE - PIPELINE (430)	NA	0	0	0	0	0	0	0
IRRIGATION WATER MANAGEMENT (449)	+2	+2	+2	+1	+1	+1	+1	+1
LAND CLEARING (WOODLAND) (460)	0	0	NA	0	0	NA	-1	-1
LAND RECONSTRUCTION (ABANDONED MINE LAND) (543)	NA	0	0	+1	0	+1	0	0
LAND RECONSTRUCTION (CURRENT MINE LAND) (544)	NA	0	0	0	+1	0	+1	+1
LAND SMOOTHING (466)	+1	+1	+1	+/-	+/-	+/-	0	0
LINED WATERWAY OR OUTLET (468)	0	0	0	0	0	0	0	0
MULCHING (484)	+1	+1	0	+1	+1	0	+1	+1
NUTRIENT MANAGEMENT (DEFICIT) (590D)	+2	+2	+/-	+2	+1	+1	+1	+1
NUTRIENT MANAGEMENT (EXCESS) (590E)	+2	+2	+/-	+2	+1	+1	+1	+1
OPEN CHANNEL (582)	NA	0	0	0	+1	0	0	-1
PASTURE AND HAYLAND MANAGEMENT (510)	+1	+1	+1	+1	+1	+1	+1	0

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL CONTAMINANTS	GROUND WATER CONTAMINANTS		SURFACE WATER CONTAMINANTS			SUSPENDED SEDIMENT AND TURBIDITY	AQUATIC HABITAT SUITABILITY
	EXCESS ANIMAL MANURES AND OTHER ORGANICS	NUTRIENTS AND ORGANICS	PATHOGENS	NUTRIENTS AND ORGANICS	LOW DISSOLVED OXYGEN	PATHOGENS		
PASTURE AND HAYLAND PLANTING (512)	+1	+1	0	+1	+1	0	+1	+1
PRECISION LAND FORMING (462)	+1	+1	+1	+/-	+/-	+/-	0	0
PLANNED GRAZING SYSTEM (556)	+1	+1	+/-	+1	+1	+/-	+1	+1
POND (378)	NA	+/-	+/-	0	0	0	0	0
POND SEALING OR LINING (521)	0	+/-	0	0	0	0	0	0
POULTRY COMPOSTING FACILITY (313A)	+2	+2	+1	+1	+1	+1	+1	+1
PROPER GRAZING USE (528)	+2	+/-	0	+1	+1	0	0	+1
PUMPING PLANT FOR WATER CONTROL (533)	+1	+1	0	+1	0	0	0	0
RESIDUE MANAGEMENT (NO TILL/ STRIP) (329A)	+1	+1	+1	+1	+1	+1	+1	+1
RESIDUE MANAGEMENT (MULCH TILL) (329B)	+1	+1	+1	+1	+1	+1	+1	+1
RESIDUE MANAGEMENT (RIDGE TILL) (329R)	+1	+1	+1	+1	+1	+1	+1	+1
RESIDUE MANAGEMENT (SEASONAL) (344)	+1	+1	+/-	+1	+1	+1	+1	+1
RIPARIAN FOREST BUFFER (391)	+1	+2	+1	+2	+2	+1	+2	+2

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL CONTAMINANTS	GROUND WATER CONTAMINANTS		SURFACE WATER CONTAMINANTS			SUSPENDED SEDIMENT AND TURBIDITY	AQUATIC HABITAT SUITABILITY
	EXCESS ANIMAL MANURES AND OTHER ORGANICS	NUTRIENTS AND ORGANICS	PATHOGENS	NUTRIENTS AND ORGANICS	LOW DISSOLVED OXYGEN	PATHOGENS		
ROW ARRANGEMENT (557)	+1	+1	0	+1	+1	0	+1	+1
RUNOFF MANAGEMENT SYSTEM (570)	NA	0	0	+1	+/-	+/-	+2	0
SEDIMENT BASIN (350)	0	-1	0	+2	+1	0	+2	+2
STRIP CROPPING (CONTOUR) (585)	+1	+2	0	+2	+1	0	+1	+1
STRIP CROPPING (FIELD) (586)	+1	+2	0	+2	+1	0	+1	+1
STRUCTURE FOR WATER CONTROL (587)	+1	-1	0	+1	+1	0	0	+2
SUBSURFACE DRAIN (606)	+1	+1	+1	-2	-1/+1	-1/+1	+1	-1/-2
SURFACE DRAINAGE FIELD DITCH (607)	+1	+/-	+/-	-1	-1	+/-	-1	-1
SURFACE DRAINAGE MAIN OR LATERAL (608)	+1	+/-	+/-	-1	-1	+/-	-1	-1
SURFACE ROUGHENING (609)	0	0	0	+2	+1	0	+1	+1
TERRACES (GRADIENT) (600G)	+1	0	0	+1	+1	+/-	+1	0
TERRACES (STORAGE) (600S)	+1	0	0	+/-	+/-	+/-	+1	0
UNDERGROUND OUTLETS (620) *	0	0	0	-1/+1	+1	-1/+1	+1	+1
USE EXCLUSION (472)	+2	+2	0	+2	+2	0	+1	+2

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL CONTAMINANTS	GROUND WATER CONTAMINANTS		SURFACE WATER CONTAMINANTS			SUSPENDED SEDIMENT AND TURBIDITY	AQUATIC HABITAT SUITABILITY
	EXCESS ANIMAL MANURES AND OTHER ORGANICS	NUTRIENTS AND ORGANICS	PATHOGENS	NUTRIENTS AND ORGANICS	LOW DISSOLVED OXYGEN	PATHOGENS		
VERTICAL DRAIN (630)	0	0	0	-1/+1	+/-	-1/+1	+1	0
WASTE MANAGEMENT SYSTEM (312)	+2	+2	+/-	+2	+1	+1	+1	+1
WASTE STORAGE POND (425)	+2	+2	+/-	+2	+1	+/-	+1	+1
WASTE STORAGE STRUCTURE (313)	+2	+2	+/-	+2	+1	+/-	+1	+1
WASTE TREATMENT LAGOON (359)	+2	+2	+/-	+2	+1		+1	+1
WASTE UTILIZATION (633)	+2	+2	+/-	+2	+1	+1	+1	+1
WATER AND SEDIMENT CONTROL BASIN (638)	0	0	+/-	+1	+1	+/-	+2	+1
WETLAND RESTORATION (INTERIM) (657)	NA	+1	+1	+2	+2	+1	+2	+2
WILDLIFE WETLAND HABITAT MANAGEMENT (644)	NA	+1	+1	+2	+2	+1	+2	+2
WINDBREAK/SHELTERBELT ESTABLISHMENT (380)	+1	+1	+1	+1	NA	NA	+1	+1

THE FOLLOWING CONSERVATION PRACTICES DO NOT HAVE APPLICABILITY TO NONPOINT SOURCE WATER QUALITY IMPACTS RESULTING FROM MANURE MANAGEMENT.

BRUSH MANAGEMENT (BIOLOGICAL) (314B)
BRUSH MANAGEMENT (CHEMICAL) (314C)
BRUSH MANAGEMENT (MECHANICAL) (314M)
BRUSH MANAGEMENT (BURNING) (314F)
Clearing and Snagging (326)
Fencing (382)
Firebreak (394)

Forest Stand Improvement (666)
Obstruction Removal (500)
Pest Management (Biological) (595b)
Pest Management (Chemical) (595c)
Pest Management (Mechanical) (595m)
Pipeline (516)
Prescribed Burning (338)
Proper Woodland Grazing (530)
RECREATION AREA IMPROVEMENT (562)
RECREATION LAND GRADING AND SHAPING (566)

RECREATION TRAIL AND WALKWAY (568)
SPOIL SPREADING (572)
SPRING DEVELOPMENT (574)
STREAM BANK AND SHORELINE PROTECTION (580)
STREAM CHANNEL STABILIZATION (584)
TREE / SHRUB PLANTING (612)
TROUGH OR TANK (614)
WELL (IRRIGATION) (642I)
WELL (LIVESTOCK AND WILDLIFE) (642L)
WILDLIFE UPLAND HABITAT MANAGEMENT (645)
WILDLIFE WATER FACILITY (648)

WOODLAND IMPROVED HARVEST (FINAL) (654F)

WOODLAND PRUNING (660)
WOODLAND SITE PREPARATION (490)

Note: The Conservation Practice Effects for Underground Outlets (620) depends on where the tile outlets: directly into a stream or onto vegetation.

TABLE 10: NONPOINT SOURCE WATER QUALITY IMPACTS DERIVED FROM PASTURE MANAGEMENT PRACTICES APPLIED TO AGRICULTURAL LANDS (11/03)

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL TILTH, CRUSTING, WATER INFILTRATION, ORGANIC MATERIALS	SOIL CONTAMINANTS	GROUND WATER CONTAMINANTS		SURFACE WATER CONTAMINANTS			SUSPENDED SEDIMENT AND TURBIDITY	AQUATIC HABITAT SUITABILITY
		EXCESS ANIMAL MANURES AND OTHER ORGANICS	NUTRIENTS AND ORGANICS	PATHOGENS	NUTRIENTS AND ORGANICS	LOW DISSOLVED OXYGEN	PATHOGENS		
ACCESS ROAD (560)	NA	0	+1	NA	+1	0	NA	+1	+1
BRUSH MANAGEMENT (BIOLOGICAL) (314B)	+1	NA	+/-	NA	+/-	0	NA	0	0
BRUSH MANAGEMENT (CHEMICAL) (314C)	+1	NA	+/-	NA	+/-	0	NA	0	0
BRUSH MANAGEMENT (MECHANICAL) (314M)	+/-	NA	+/-	NA	+/-	-1	NA	-1	0
BRUSH MANAGEMENT (BURNING) (314F)	+1	NA	+/-	NA	+/-	-1	NA	-1	0
CONSERVATION COVER (327)	+1	+1	+1	0	+1	+1	0	+1	+1
CONTOUR BUFFER STRIP (332)	NA-	+1	+1	+1	+2	+2	+2	+2	+2
CRITICAL AREA PLANTING (342)	+2	+1	+1	0	+1	+1	0	+1	+1
DEFERRED GRAZING (352)	+2	+2	+2	0	+1	+1	0	+1	+1
DIKE (EARTHEN) (356)	0	0	0	0	+1	+1	+1	+1	+1
DIVERSION (362)	0	0	-1	0	+1	+1	+1	+1	0
FENCING (382)	+1	+1	+1	0	+1	+1	+1	+1	+1
FIELD BORDER (386)	+1	+1	NA	NA	+1	NA	NA	0	+1

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL TILTH, CRUSTING, WATER INFILTRATION, ORGANIC MATERIALS	SOIL CONTAMINANTS	GROUND WATER CONTAMINANTS		SURFACE WATER CONTAMINANTS			SUSPENDED SEDIMENT AND TURBIDITY	AQUATIC HABITAT SUITABILITY
		EXCESS ANIMAL MANURES AND OTHER ORGANICS	NUTRIENTS AND ORGANICS	PATHOGENS	NUTRIENTS AND ORGANICS	LOW DISSOLVED OXYGEN	PATHOGENS		
FIELD WINDBREAK (392)	+1	NA	+1	0	+1	0	0	+1	0
FILTER STRIP (393)	0	0	+1	0	+1	+1	0	+2	+2
GRADE STABILIZATION STRUCTURE (410)	NA	NA	0	0	0	0	0	+1	0
GRASSED WATERWAY (412)	0	0	0	0	+1	0	0	+1	0
GRASSES AND LEGUMES (ROTATION) (411)	+2	+1	+2	+1	+2	+1	+1	+2	+1
HEAVY USE AREA PROTECTION (561)	+1	NA	0	0	+1	+1	+1	+2	+1
LAND RECONSTRUCTION (ABANDONED MINE LAND) (543)	+1	NA	0	0	+1	0	+1	+1	+1
LAND RECONSTRUCTION (CURRENT MINE LAND) (544)	+1	NA	0	0	0	+1	0	+1	+1
LINED WATERWAY OR OUTLET (468)	NA	0	0	0	0	0	0	0	0
NUTRIENT MANAGEMENT (DEFICIT) (590D)	+1	+2	+2	NA	+2	+1	NA	+1	+1
NUTRIENT MANAGEMENT (EXCESS) (590E)	+1	+2	+2	NA	+2	+1	NA	+1	+1
PASTURE AND HAYLAND MANAGEMENT (510)	+2	+1	+1	+/-	+1	+1	+/-	+1	+1
PASTURE AND HAYLAND PLANTING	+2	+2	+1	+1	+1	+1	+/-	+1	0

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL TILTH, CRUSTING, WATER INFILTRATION, ORGANIC MATERIALS	SOIL CONTAMINANTS	GROUND WATER CONTAMINANTS		SURFACE WATER CONTAMINANTS			SUSPENDED SEDIMENT AND TURBIDITY	AQUATIC HABITAT SUITABILITY
		EXCESS ANIMAL MANURES AND OTHER ORGANICS	NUTRIENTS AND ORGANICS	PATHOGENS	NUTRIENTS AND ORGANICS	LOW DISSOLVED OXYGEN	PATHOGENS		
(512)									
PEST MANAGEMENT (BIOLOGICAL) (595B)	NA	NA	NA	NA	NA	NA	NA	+2	+2
PEST MANAGEMENT (CHEMICAL) (595C)	NA	NA	NA	NA	NA	NA	NA	+/-	0
PEST MANAGEMENT (MECHANICAL) (595M)	NA	NA	NA	NA	NA	NA	NA	-1	+/-
PIPELINE (516)	0	NA	NA	NA	NA	NA	NA	+1	+1
PLANNED GRAZING SYSTEM (556)	+1	+1	+/-	+/-	+1	+1	+/-	+1	+1
POND (378)	NA	NA	+/-	+/-	0	0	0	0	+/-
POND SEALING OR LINING (521)	+1	0	+1	0	0	0	0	0	0
PRESCRIBED BURNING (338)	NA	0	0	0	-1	-1	+1	-1	-1
PROPER GRAZING USE (528)	0	+1	+/-	+/-	+1	+1	+/-	+1	+1
PROPER WOODLAND GRAZING (530)	0	+1	+/-	0	+/-	+/-	+/-	+/-	0
RESIDUE MANAGEMENT (NO TILL/ STRIP) (329A)	+/-	+1	+1	0	+1	+1	0	+1	+1
RESIDUE MANAGEMENT (MULCH TILL) (329B)	+/-	+1	+1	0	+1	+1	0	+1	+1
RESIDUE MANAGEMENT (RIDGE	+/-	+1	+1	0	+1	+1	0	+1	+1

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL TILTH, CRUSTING, WATER INFILTRATION, ORGANIC MATERIALS	SOIL CONTAMINANTS	GROUND WATER CONTAMINANTS		SURFACE WATER CONTAMINANTS			SUSPENDED SEDIMENT AND TURBIDITY	AQUATIC HABITAT SUITABILITY
		EXCESS ANIMAL MANURES AND OTHER ORGANICS	NUTRIENTS AND ORGANICS	PATHOGENS	NUTRIENTS AND ORGANICS	LOW DISSOLVED OXYGEN	PATHOGENS		
TILL) (329R)									
RESIDUE MANAGEMENT (SEASONAL) (344)	+/-	+1	+1	0	+1	+1	0	+1	+1
RIPARIAN FOREST BUFFER (391)	+1	+1	+2	+1	+2	+2	+1	+2	+2
RUNOFF MANAGEMENT SYSTEM (570)	+1	NA	+/-	+/-	+1	+/-	+/-	+2	0
SEDIMENT BASIN (350)	0	+/-	0	0	+1	+1	-1	+2	0
SPRING DEVELOPMENT (574)	0	0	+1	+1	+1	0	+1	+1	0
STREAM BANK AND SHORELINE PROTECTION (580)	0	+1	0	0	+1	+1	+1	+2	+2
STREAM CHANNEL STABILIZATION (584)	0	0	0	0	+2	+1	+1	+2	+2
SURFACE DRAINAGE FIELD DITCH (607)	+1	+1	0	0	-1	-1	-1	-1	-1
SURFACE DRAINAGE MAIN OR LATERAL (608)	+1	+1	0	0	-1	-1	-1	-1	-1
TROUGH OR TANK (614)	+1	+1	+1	+/-	+1	0	+1	+2	+2
USE EXCLUSION (472)	+2	+1	-1	+1	+2	+2	+2	+1	+2
WASTE UTILIZATION (633)	+2	+2	+1	0	+1	0	0	+1	+1
WELL (LIVESTOCK AND WILDLIFE)	+1	+1	+1	0	+1	0	0	+2	+2

CONSERVATION PRACTICE/ (NRCS CODE)	SOIL TILTH, CRUSTING, WATER INFILTRATION, ORGANIC MATERIALS	SOIL CONTAMINANTS	GROUND WATER CONTAMINANTS		SURFACE WATER CONTAMINANTS			SUSPENDED SEDIMENT AND TURBIDITY	AQUATIC HABITAT SUITABILITY
		EXCESS ANIMAL MANURES AND OTHER ORGANICS	NUTRIENTS AND ORGANICS	PATHOGENS	NUTRIENTS AND ORGANICS	LOW DISSOLVED OXYGEN	PATHOGENS		
(642L)									
WETLAND RESTORATION (INTERIM) (657)	NA	NA	+1	+1	+2	+2	+1	+2	+2
WILDLIFE UPLAND HABITAT MANAGEMENT (645)	+/-	0	+1	0	+1	0	0	+2	+1
WILDLIFE WATER FACILITY (648)	+1	+1	+1	+/-	+1	0	+/-	+2	+2
WILDLIFE WETLAND HABITAT MANAGEMENT (644)	NA	NA	+1	+1	+2	+2	+1	+2	+2
WINDBREAK/SHELTERBELT ESTABLISHMENT (380)	+2	0	+/-	0	+/-	0	0	0	0

**THE FOLLOWING CONSERVATION PRACTICES DO NOT HAVE APPLICABILITY TO NONPOINT SOURCE WATER QUALITY
RESULTING FROM PASTURE MANAGEMENT.**

CHISELING AND SUB-SOILING (324A)	OBSTRUCTION REMOVAL (500)
CHISELING AND SUB-SOILING (324B)	OPEN CHANNEL (582)
CLEARING AND SNAGGING (326)	PRECISION LAND FORMING (462)
COMMERCIAL FISH PONDS (397)	POULTRY COMPOSTING FACILITY (313A)
CONSERVATION CROP ROTATION (328)	PUMPING PLANT FOR WATER CONTROL (533)
CONTOUR FARMING (330)	RECREATION AREA IMPROVEMENT (562)
COVER AND GREEN MANURE CROP (340)	RECREATION LAND GRADING AND SHAPING (566)
CROSS WIND RIDGES (589A)	RECREATION TRAIL AND WALKWAY (568)
CROSS WIND STRIP CROP (589B)	ROW ARRANGEMENT (557)
CROSS WIND TRAP STRIP (589C)	SPOIL SPREADING (572)
DAM, DIVERSION (348)	STRIP CROPPING (CONTOUR) (585)
DAM, FLOODWATER RETARDING (402)	STRIP CROPPING (FIELD) (586)
DAM, MULTIPLE PURPOSE (349)	STRUCTURE FOR WATER CONTROL (587)
DEEP TILLAGE (INTERIM) (XXX)	SUBSURFACE DRAIN (606)
FIREBREAK (394)	SURFACE ROUGHENING (609)
FISHPOND MANAGEMENT (399)	TERRACES (GRADIENT) (600G)
	TERRACES (STORAGE) (600S)
FOREST STAND IMPROVEMENT (666)	UNDERGROUND OUTLETS (620)
HEDGEROW PLANTING (422)	VERTICAL DRAIN (630)
HERBACEOUS WIND BARRIERS (422A)	WASTE MANAGEMENT SYSTEM (312)
IRRIGATION FIELD DITCH (388)	WASTE STORAGE POND (425)
IRRIGATION LAND LEVELING (464)	WASTE STORAGE STRUCTURE (313)
IRRIGATION PIT OR REGULATING RESERVOIR (552)	WASTE TREATMENT LAGOON (359)
IRRIGATION STORAGE RESERVOIR (436)	WATER AND SEDIMENT CONTROL BASIN (638)
IRRIGATION SYSTEM - TRICKLE (MICRO) (441)	WELL (IRRIGATION) (642I)
IRRIGATION SYSTEM - SPRINKLER (442)	
IRRIGATION SYSTEM - SURFACE AND SUBSURFACE (443)	WOODLAND IMPROVED ARVEST (FINAL) (654F)
IRRIGATION SYSTEM -TAIL WATER RECOVERY (447)	
IRRIGATION WATER CONVEYANCE - DITCH (428)	WOODLAND PRUNING (660)
IRRIGATION WATER MANAGEMENT (449)	WOODLAND SITE PREPARATION (490)
LAND SMOOTHING (466)	
MULCHING (484)	

**AGRICULTURAL CONSERVATION PRACTICES
FOR
WATER QUALITY
11/2003**

Access Road (560)

A travel way constructed as part of a conservation plan. It applies to roads constructed to provide access to farms, ranches, fields, conservation systems, structures, and recreational areas; to transport equipment or supplies; to operate and maintain the conservation enterprise.

Brush Management (314)

Removal, reduction, or manipulation of excessive non-herbaceous plants on rangeland, native or naturalized pasture lands is desired to maintain a diversity of vegetation for forage production. This practice is applied as part of a Conservation Management System to accomplish one or more of the following purposes. It can be used to restore the natural plant community balance; create the desired plant community; reduce competition for space, moisture, and sunlight between desired and unwanted plants; manage noxious woody plants; restore desired vegetative cover to protect soils, control erosion, reduce sediment, improve water quality and enhance stream flow; maintain or enhance wildlife habitat including that associated with threatened and endangered species; improve forage accessibility, quality and quantity for livestock; protect life and property from wildfire hazards, and improve visibility and access for handling livestock. Water quality may be impacted for a short-duration from soil disturbance that will cause soil erosion and sediment transport with potential soluble substances carried in surface runoff water.

Chiseling And Subsoiling (324)

Loosening the soil, without inverting and a minimum of mixing of the surface soil, to shatter restrictive layers below the normal plow depth. This restrictive layer inhibits water movement or root development. This practice will improve water and root penetration plus improve aeration of the soil. This practice works best when properly applied to suitable soils with restrictive layer(s) depths of less than 16 inches. Water quality improvement results from greater infiltration rates and root penetration to utilize a greater rooting and absorption depth for nutrients and soil moisture. If improperly applied, not on the contour, the practice will create greater soil erosion and sedimentation to surface waters.

Clearing And Snagging (326)

Removal of snags, drifts, or other obstructions from a channel. This applies to the clearing of trees, brush and the removal of sediment bars, drifts, logs, snags, boulders, piling, piers, head walls, debris, and other obstructions from the flow area of a natural or excavated channel. The flow capacity will be increased through improved flow characteristics by preventing bank erosion resulting from eddies; to reduce sediment bar formation; to reducing chances for ice jams. Special consideration is given to maintaining habitat for fish and other wildlife. Prior to design and installation contact local, state, and federal regulatory agencies for appropriate permit(s) to work in the stream or floodplain.

Commercial Fishpond (397)

A water impoundment constructed and managed for commercial aquaculture production. It applies to impoundments modified to enhance the production of fish, wildlife, or plants for resale, including fee harvesting on the site.

Conservation Cover (327)

This is the establishment and maintenance of perennial vegetative cover to protect soil and water resources retired from agricultural production. The practice is designed to reduce soil erosion and sedimentation while improving water quality and wildlife habitats. This practice does not meet the same criteria for forage production or critical area plantings. Several seeding mixtures are created to enhance water quality.

Conservation Crop Rotation (328)

This is the growing of crops in a recurring sequence on the same field. The rotation supports the Conservation Management System or Integrated Crop Management system to reduce sheet and rill erosion; reduce irrigation induced erosion; maintain or improve soil organic matter; reduce wind erosion; manage deficient or excessive crop nutrients; improve water efficiency; manage crop pests (weeds, insects, nematodes, and diseases); provide food for domestic livestock; and food and cover for wildlife. Cropping rotations can also aid in improving soil quality. This does not apply to specialty crops or pastureland.

Contour Buffer Strips (332)

This is a narrow strips of perennial vegetative cover established on the contour across the slope alternated with wider cropped strips down slope. The beneficial effects of these strips include reduced sheet and rill erosion; reduced transport of sediment and other water-borne contaminants down slope, on-site and off-site in addition to enhancing wildlife habitat on sloping cropland. This is adapted best to nearly uniform topography to maintain parallel strips across the slope. These strips are not considered cropland or a part of the crop rotation.

Contour Farming (330)

Farming sloping lands in such a way that land preparation, planting, cultivation and harvesting is done on the contour. (This includes following established grades of terraces or diversions.) The practice reduces sheet and rill erosion and controls water runoff. It is used where other cultural and management practices do not control soil and water losses. It often is used in combination with other structural and non-structural conservation practices to enhance benefits.

Cover And Green Manure Crop (340)

A crop of close-growing grasses, legumes, or small grain grown primarily for seasonal protection and soil improvement. It is usually grown for one year or less, except where there is permanent cover as in orchards. This is used to control erosion where major crops do not yield adequate crop residues; to add organic matter to the soil; to improve rainfall infiltration, soil aeration, and tilth; also to retrieve soil nutrients leached out of the root zones of shallow-rooted crops in the fall through spring seasons.

Critical Area Planting (342)

Planting vegetation such as trees, shrubs, vines, grasses or legumes on highly erodible or critically eroding areas (does not include tree planting mainly for wood products.) This planting will stabilize soil, reduce damaging sediment and water runoff to downstream areas while improving wildlife habitat and visual effects. This is applicable to dams, dikes, borrow areas, ditch banks, waterways, diversions, grassed terraces, mine spoil, levees, road cuts and fills, surface mined areas, denuded areas, gullies and urban sites where usual establishment methods prove difficult.

Cross Wind Ridges (589a)

Ridges formed by tillage or planting and aligned across the prevailing wind erosion direction. This is applied as part of a Conservation Management System or Integrated Crop Management system to reduce wind erosion. It is applicable to croplands with stable soils (clayey, silty and silt loam soils) which can sustain stable ridges.

Cross Wind Stripcropping (589b)

Growing crops in strip widths of 660 feet or less established across the prevailing wind erosion direction, and arranged so that strips susceptible to wind erosion are alternated with strips having a protective cover that is resistant to wind erosion. This may be applied as a part of Conservation Management System or Integrated Crop Management system to support reduced wind erosion and/or protecting fragile crop plant tissues from abrasive wind-borne soil particles. Strips should be nearly as perpendicular as possible to the prevailing winds.

Cross Wind Trap Strips (589c)

Herbaceous cover resistant to wind erosion established in one or more strips across the prevailing wind erosion direction. When applied as a part of the Conservation Management System or Integrated Crop Management system it provides reduced wind erosion; increased deposition of wind-borne sediment and attached contaminants on these sediments; crop protection from abrasive action of wind-borne soil particles, and provides wildlife food and cover. These strips are most effective when installed perpendicular to the prevailing winds.

Dam, Diversion (348)

A structure built to divert part or all of the water from a waterway or a stream into a different watercourse, an irrigation canal or ditch, or a water spreading system. These are permanent structures to divert part or all of the water in a controlled manner for beneficial concerns and/or to divert damaging runoff water from designed frequency floods. This is applicable to an irrigation system of a water spreading plan to conserve soil and water. Diverted water will have positive benefits to the aquatic ecosystem.

Dam, Floodwater Retarding (402)

A single-purpose dam designed for temporary storage of floodwater and for its controlled release. The installed structure will reduce downstream damages through controlled release rates based on flow frequencies consistent with environmental hazards and potential pollution. Aquatic and wildlife habitats and water quality are improved through sustained flows.

Dam, Multiple Purpose (349)

A dam constructed across a stream or a natural watercourse that has a designed reservoir storage capacity for two or more purposes. Storage can be designed for floodwater retardation, public drinking water supply, irrigation, livestock watering, fishing, hunting, boating, swimming, improved environmental concerns, habitat for fish and wildlife, municipal or industrial uses and other uses.

Deferred Grazing (352)

Postponing grazing or resting grazing land for a prescribed period to promote natural regeneration through increased forage stand, vigor, and allowing desirable plants to propagate. It also is used to allow for a forage feed reserve for fall or winter grazing, emergency uses; improve hydrologic conditions resulting in reduced soil loss and improved infiltration; better distribution and use of animal nutrients for water quality protection.

Dike, (Earthen) (356)

An embankment constructed of earth or other suitable materials to protect land against overflow or inundation to protect land and property for floodways and/or wildlife enhancements. Dikes have three levels of design: 1) to improve agricultural lands to prevent damage by over land flows; 2) to facilitate water storage and control for wildlife wetlands; and 3) to protect natural areas, historic and scenic features, and archeological sites from damage.

Diversion (362)

A channel with a supporting ridge on the lower side constructed across the slope so as to divert excess surface water from vulnerable areas to sites where it can be used or safely managed. It applies to areas where runoff from an area is damaging the area lying downslope; surface or subsurface flow causes seepage; pollution abatement systems; and/or urban and suburban developing areas and construction sites. It is not meant to be a substitute for a planned terrace system unless used in combination with other upland erosion control measures.

Fencing (382)

Enclosing or dividing an area of land with a suitable permanent structure that acts as a barrier to livestock, big game, or people. (Does not include temporary fences.) It should protect areas from grazing damage such as woodlands, wildlife areas, or stream banks; confining livestock; sub-divide grazing areas within a grazing system; protect seedlings or plantings; regulate access to areas from people or prevent trespassing; and provide safety and security for livestock and humans.

Field Border (386)

A strip of perennial vegetation established at the edge of a field by planting or by converting it from trees to herbaceous vegetation or shrubs. It provides wildlife food, cover, and travel lanes; erosion control; provides edge of fields as machinery travel lanes or “turn-arounds,” eliminates end rows; provides for outlets when contour farming; reduces woody plant competition; improves water quality through reduction of nutrient and pesticide application overlaps; and improves aesthetics. It is applicable to stream banks, ditch berms, roads, trails, woodland-cropland and wildlife area-cropland interface zones.

Filter Strip (393)

A strip or area of vegetation for removing sediment, organic matter, and other pollutants from field surface water runoff and feedlot runoff water. [This is not to be confused with field borders or contour buffer strips.] This is applicable to removing potential contaminants from sheet flow runoff water and livestock manure runoff water. The practice increases infiltration, deposition, adsorption, absorption, decomposition, and volatilization of pollutants carried by surface runoff water.

Firebreak (394)

A strip of bare land or vegetation that retards fire to protect soil, water, air, plant, animal, and human resources by preventing the spread of wildfire or to control prescribed burns. Firebreaks may be temporary or permanent. It is applicable to all land uses where protection from wildfire is needed or a prescribed burn is applied. Water quality impairment may occur during the initial re-establishment period or immediately after a wildfire providing sediment or nutrients.

Fish Pond Management (399)

Developing or improving impoundment water to produce fish for domestic use or recreation. This provides favorable aquatic habitat, supplemental food sources and management of unwanted plants and animals in the fishery resource. Management includes proper stocking rates, correct harvesting, aquatic vegetation management, fertility, water control and quality, and habitat improvement.

Forest Stand Improvement (666)

It is the manipulation of specie composition and stocking by cutting or killing selected trees and under story vegetation for the goal of improving and/ or sustaining timber production; harvesting wood or other products; initiate stand regeneration; and improve under story aesthetics, recreational uses, and wildlife habitat. Water quality and hydrology is enhanced with an intensive management plan guiding specie selection and harvesting operations.

Grade Stabilization Structure (410)

A structure used to control the grade and head cutting in natural or artificial channels. This will provide grade and erosion controls while not allowing gully advancement and sustaining the environment. It will improve environmental quality through reduction of potential pollution hazards to streams and other water bodies and human safety issues.

Grassed Waterway (412)

A natural or constructed channel that is shaped or graded to required dimensions and established in suitable vegetation for the stable conveyance of runoff. [Stone centered waterways are included in this standard.] Waterways convey surface water runoff safely from terraces, diversions, or other water concentrations without causing erosion, flooding and improving water quality. Water quality improvements result from reduction in sediment delivered and the entrapment of sediment, attached pesticides and nutrients from the areas serviced. Waterways have not fully proven to benefit reductions of pesticides in solution resulting from a significant runoff event.

Heavy Use Area Protection (561)

Protecting heavily used areas by establishing vegetative cover, by surfacing with suitable materials, or by installing needed structures on urban, recreational, and structural areas frequented by people, animals, or vehicles. Protection extends to reducing soil erosion and proper management of runoff water to avoid potential surface and ground water contamination.

Hedgerow Planting (422)

Establishing a living fence of shrubs or trees in, across or around a field, to serve as field or property boundaries; living fences; contour guidelines; wildlife food cover and travel; or visual screens. Hedgerows will enhance water quality through increased entrapment of sediment, nutrients, and pesticides while improving wildlife and aesthetics.

Herbaceous Wind Barriers (422a)

Annual or perennial herbaceous vegetation established in rows or narrow strips across the prevailing wind direction. This is applied as a part of a Conservation Management System to support reduced wind erosion; protection of plants from abrasive wind-borne soil particles; manage snow catchment to improve soil moisture; improve wildlife habitat; and integrate beneficial plants, animals, and insects in pest management programs.

Irrigation Field Ditch (388)

A permanent irrigation ditch constructed to convey water from the source of supply to a field or fields in a farm distribution system. This applies to open ditches or channels excluding seasonal surface ditches. A properly designed ditch will reduce soil erosion; improve water quality; and more efficient conveyance without water losses and deep percolation of potential nutrients and pesticides to ground water.

Irrigation Land Leveling (464)

Reshaping the surface of land to be irrigated to planned grades to permit uniform and efficient application of irrigation water without causing soil erosion, loss of water quality, or damage resulting from water-logging while at the same time providing adequate surface drainage. All leveling will be done to facilitate conservation of soil and water resources while preventing water quality degradation from pesticides, nutrients, and sediments.

Irrigation Pit or Regulating Reservoir (552)

A small storage reservoir constructed to regulate or store a supply of water for irrigation until it can be used beneficially to satisfy crop needs. Application of irrigation water as the crop needs dictate brings about greater efficiency and allows for the recapture of potentially contaminated water from pesticides and nutrients.

Irrigation Storage Reservoir (436)

An irrigation water storage structure made by constructing a dam. Surface water is captured and stored during months of low irrigation needs and applied during months of greatest crop needs.

Irrigation System, Trickle [Micro] (441)

A planned irrigation system in which all necessary facilities are installed for efficiently applying water directly to the root zone of plants by means of applicators (orifices, emitters, porous tubing, perforated pipe) operated under low pressure. The applicators can be placed on or below the surface of the ground. Trickle irrigation allows for better soil moisture maintenance in the plant rooting zone without saturating the soil profile that causes the potential leaching of nutrients and/or pesticides. This practice reduces soil erosion; improves water quality; and reduces salt concentrations.

Irrigation System, Sprinkler (442)

A planned irrigation system in which all necessary facilities are installed for efficiently applying water for irrigation by means of perforated pipes or nozzles operated under high or low pressure and/or volumes. This allows for efficient uniform application to maintain adequate soil moisture to optimize plant growth while reducing soil erosion, excessive water loss, and degradation of water quality from nutrients and pesticides. This is suited to most crops except rice and orchards.

Irrigation System, Surface And Subsurface (443)

A planned irrigation system in which all necessary water-controlled structures have been installed for the efficient distribution of irrigation water by surface means, such as furrows, borders, contour levees, or contour ditches, or by subsurface means. This system applies to overall irrigation water distribution and livestock lagoon water handling systems for a given farming enterprise. This system seeks to maximize

efficiency to convey and distribute irrigation water to the point of application without causing soil erosion, water losses, and degradation of water quality.

Irrigation System, Tailwater Recovery (447)

A facility to collect, store, and transport irrigation tailwater for reuse in a farm irrigation distribution system. This practice seeks to maximize water supplies while protecting water quality by recycling the potentially contaminated excess water.

Irrigation Water Conveyance- Ditch (428)

A lining of fixed or flexible impervious material installed in an existing or newly constructed irrigation field ditch, irrigation canal, or lateral. This practice prevents waterlogging of land, to maintain water quality, to prevent erosion, and to reduce water loss. This serves as an integral part of a Conservation Management System to facilitate conservation of soil and water resources on the farm. The practice benefits to water quality are reduced soil erosion and sedimentation, reduced movement of dissolved substances to ground water, improved wetland and other water related wildlife habitats, and the improved visual appearance of the water resources.

Irrigation Water Conveyance- Pipeline (430)

A pipeline and appurtenances installed in an irrigation system to prevent soil erosion, loss of water, degradation of water quality, and/or damage to the land. This helps maximize water conservation.

Irrigation Water Management (449)

Determining and controlling the rate, amount, and timing of irrigation water in a planned and efficient manner for the crops needs at each stage of its' life-cycle. Proper management will minimize soil erosion, loss of nutrients and pesticides, control undesirable water losses from the surface and rooting-zone, and protect water quality from potential contaminants.

Land Reconstruction, Abandoned Mine Land (543)

Restoring land and water areas that are adversely affected by past mining practices and increasing the productivity of the area for a beneficial use. The practice leads to stabilization of mined areas to support vegetation, reduce soil erosion, enhance water quality and/or quantity, provide wildlife habitat, improved aesthetics, public health, safety and welfare. Reclamation standards are based on the intended land uses.

Land Reconstruction, Current Mine Land (544)

Restoring currently mined land to an acceptable form and for a planned use to prevent permanent damage to soil and water resources in and near mined areas. Additionally as part of a Conservation Management System, it will restore the productivity of the soils to permit their pre-mining use or a more intensive use while controlling erosion, preserving the environment, maintaining an economic use of the land and maintaining the aesthetic quality. Water quality improvements include reduced sediment, potential toxic and soluble substances while providing wildlife habitat enhancements.

Land Smoothing (466)

Removing irregularities on the land surface by use of special equipment. This is classified as a rough grading to improve surface drainage for more effective use of precipitation, uniform planting depths, uniform cultivation, improved equipment operation, terrace alignments, and to facilitate contour cultivation.

Lined Waterway or Outlet (468)

A waterway or outlet having an erosion-resistant lining of concrete, broken concrete (without metal rods or wires), stone, or other permanent material. The lined section extends up the side slopes to a designed depth. The earth above the permanent lining may be vegetated or otherwise protected. This type of waterway should not exceed a design capacity of 200 cubic feet per second. This designed waterway provides for safe runoff flows where an unlined waterway would be inadequate due to seepage contributions or unstable soils.

Mulching (484)

Applying plant residues or other suitable materials not produced on the site to the soil surface. This is a part of the Conservation Management System to protect vegetative cover or crops during establishment periods and/or to reduce weed competition, modify the growing environment of new plants, increase infiltration, and reduce soil erosion from disturbed construction sites.

Nutrient Management (Deficit) (590d)

Managing the amount, form, placement, and timing of applications of plant nutrients to supply plant nutrients for optimum forage or crop yields or to supply plant nutrients minimizing entry into surface or ground water. Nutrients are managed from all sources used in the system such as commercial fertilizers, lime or gypsum, livestock manures or municipal wastes, or from crop credits. This is part of the Conservation Management System or Integrated Crop Management system developed by soil, crop, and field. Yields are based on realistically achievable yield goals based on site conditions and managerial capabilities. This standard recognizes that build-up is still a viable option under this situation.

Nutrient Management (Excess) (590e)

Managing the amount, form, placement, and timing of applications of plant nutrients to supply plant nutrients for optimum forage or crop yields or to supply plant nutrients minimizing entry into surface or ground water. Nutrients are managed from all sources used in the system such as commercial fertilizers, lime or gypsum, livestock manures, and municipal wastes, or from crop credits. This is part of the Conservation Management System or Integrated Crop Management system developed by soil, crop, and field. Yields are based on realistically achievable yield goals based on site conditions and managerial capabilities. This standard recognizes that build-up is not a viable option under this situation.

Obstruction Removal (500)

Disposing of rock, stone fences, hedges, or fence rows and filling gullies or abandoned roads to facilitate layout of crop rows, strip cropping, terraces, land smoothing,, roads, and other construction projects on farms ranches, and other areas. Removal of certain obstructions can aid in improving water quality by converting the concentrated surface water flows into sheet form especially where the runoff is potentially contaminated with sediment, nutrients, and pesticides which can pose a potential threat to surface and/or groundwater.

Open Channel (582)

Constructing or improving a channel, either naturally or artificially, in which water flows with a free surface. This practice is used to provide discharge capacity required for flood control prevention, drainage, other authorized water management purposes, or any combination of these purposes. Stability is important in protecting or enhancing water quality, fish and wildlife habitat.

Pasture And Hayland Management (510)

Proper treatment and use of pasture and hayland to perpetuate the desired plant resources, protect the soil from erosion, safe guard the water resource, insure air quality, and provide food and shelter for livestock and wildlife. Management should provide for optimum sustained yield of the plant resource, consistent with production goals. Harvested hay will provide feed of sufficient quality to meet producer goals. Residue will be left to filter runoff and control erosion. Pest management strategies will evaluate the toxicity of the pesticide and position relative to water sources to prevent potential contamination of surface and ground water. Applications of nutrients will evaluate the effects on water sources on adjacent lands. Grazing practices will incorporate delayed grazing to sustain the plant resources and end grazing when the plant has reached its minimum residual height.

Pasture and Hayland Planting (512)

Establishing native or introduced forage species as part of a Conservation Management System for one or more purposes. This practice is used to establish adapted or compatible species, varieties, or cultivars; improve or maintain livestock nutrition and/or health; extend the length of a grazing season; provide emergency forage production; reduce soil erosion by wind and/or water; and improve water quality and wildlife habitat. This practice is applicable to agricultural lands, cropland, pasture, hayland, etc., where forage production is feasible and desirable. Water quality will be improved through better management of

plant diversity and density, reduced sedimentation, improved infiltration, reducing potential contaminants in runoff water from pathogens, nutrients and pesticides. Proper management of plant species will enhance wildlife food, cover, and diversity beneficial to pest management.

Pest Management (Biological) (595b)

Managing agricultural pest infestations (weeds, insects, nematodes, and diseases) to reduce adverse effects on plant growth, crop production, and environmental resources (humans, animals, plants, soil, water and air). This is used as a part of a Conservation Management System to support acceptable environmentally safe pest management programs consistent with selected crop production goals. This practice is contingent on identifying the problem pests needing controls and applicable methods (biological, cultural or mechanical) to be used independently or in combination. All pest management strategies need to evaluate the stated goal for cost-effectiveness and environmental impacts.

Pest Management (Chemical) (595c)

Managing agricultural pest infestations (weeds, insects, nematodes, and diseases) to reduce adverse effects on plant growth, crop production, and environmental resources (humans, animals, plants, soil, water and air). This is used as a part of a Conservation Management System to support acceptable environmentally safe pest management programs consistent with selected crop production goals. This practice is contingent on identifying the problem pests needing controls and applicable methods (cultural or mechanical, or chemicals) to be used independently or in combination. All pest management strategies need to evaluate the stated goal for cost-effectiveness and environmental impacts.

Pest Management (Mechanical) (595m)

Managing agricultural pest infestations (weeds, insects, nematodes, and diseases) to reduce adverse effects on plant growth, crop production, and environmental resources (humans, animals, plants, soil, water and air). This is used as a part of a Conservation Management System to support acceptable environmentally safe pest management programs consistent with selected crop production goals. This practice is contingent on identifying the problem pests needing controls and applicable methods (cultural or mechanical, or rotation) to be used independently or in combination. All pest management strategies need to evaluate the stated goal for cost-effectiveness and environmental impacts. This practice depends upon use of tillage or harvest equipment with appropriate timing.

Pipeline (516)

Pipeline installed for conveying water for livestock or for recreational use and consumption. Pipelines aid in the protection of water bodies by distributing water away from these source, Source Water Protection, especially livestock. Protection of source water affords improved aquatic life and wildlife habitat.

Planned Grazing System (556)

When three or more grazing subdivisions are properly rested and then grazed in a planned sequence for two or more years to optimize forage utilization and production. It is applicable to sites where a plant community is being maintained to reduce soil erosion, safe guard water quality and air quality, and provide for livestock and wildlife food and shelter. Water quality is improved through better distribution of livestock manure, nutrients, and potential pathogenic contaminants. A grazing system is based on stocking rates and rotations for sustainable regrowth.

Pond (378)

A water impoundment made by constructing a dam or an embankment or by excavating a pit or dugout. Ponds provide water for domestic use, livestock, fish, wildlife, recreation, fire control, irrigation and other related uses. Water quality benefits from impoundments is primarily with sediment entrapment and minor benefits for nutrient and pesticide catchment.

Pond Sealing or Lining (521)

Installing a fixed lining of impervious material or treating the soil in a pond mechanically or chemically to impede or prevent excessive water loss. Numerous methods (materials) exist to seal a pond, however, costs will generally dictate what is used. Pond sealing is used where water loss is disproportional to its planned use and/or is causing other environmental problems.

Poultry Composting Facility (313a)

A structure for biological stabilization of waste organic material wherein livestock and poultry manure, dead bird and animal carcasses and food processing wastes produced on the farm are converted by micro-organisms into a stable and useful soil amendment, fertilizer substitute, or livestock nutrient. [This standard does not apply to municipal sludge, solid waste, and other non-farm type wastes.] This practice sets forth the minimum requirements to plan, design, operate, and maintain for the normal mortalities of a livestock farming operation. [It is not intended for use during a catastrophic losses.] The practice enables the carcasses to be biologically treated to prevent pollution to the environment, destroy pathogenic organisms, and produce a stable humus-like material that can be used as a soil amendment, fertilizer substitute, or livestock nutrient. It applies where a predictable mortality rate is determined for the operation; composting to properly manage the carcasses in compliance with local and state laws and regulations; and is part of a Conservation Management System which includes the developed livestock manure management plan. Water quality will be improved through proper utilization of the nutrients.

Precision Land Forming (462)

Reshaping the surface of land to planned grades for drainage and erosion control as well as other purposes such as moisture conservation, leaching, and improving water quality. [This does not include land smoothing, recreation land grading, shaping, and irrigation land leveling.] This practice provides surface drainage; allows more effective use of rainfall; facilitates installation of more workable drainage systems; reduces the incidence of mosquito infestations; controls erosion, improves water quality, and prevents damage to land by water logging. Sites will have uniform soil textures and depths to provide an adequate rooting zone to permit the planned use of the land and crops. This is part of a Conservation Management System to facilitate conservation use of soil and water resources. Water quality is improved through more efficient use of water avoiding the potential for leaching of nutrients and pesticides below the rooting zone and surface water runoff contaminants.

Prescribed Burning (338)

Applying fire to predetermined areas under conditions where the intensity and spread of the fire will be controlled. This will control undesirable vegetation, stimulate seed production, reduce excessive accumulation of plant residues, prepare sites for planting or seeding, control plant diseases, reduce hazards of a wildfire, encourage desired changes in plant diversity, improve habitat for selected wildlife species, improve forage quality for livestock, facilitate even distribution of grazing and browsing animals and increase production. Prescribed burns reduces the need for synthetic pesticides.

Pumping Plant For Water Control (533)

A pumping facility installed to transfer water for a conservation need, including removing excess surface or groundwater; filling ponds, ditches or wetlands; or pumping from wells, ponds, streams, and other sources. This assures a dependable water source or a disposal facility for water management of wetlands or provides a water supply for such uses as irrigation, livestock, recreational, or wildlife.

Recreation Area Improvement (562)

Establishing grasses, legumes, vines, shrubs, trees, or other plants or selectively reducing stand densities and trimming woody plants to improve an area for recreation. Managing the recreational area as such reduces soil erosion, provides wildlife cover and food, cover for intensive use areas, screenings, barriers, windbreaks and beautification. Water quality and quantity are benefits through increased infiltration, reducing the movement of sediment, fertilizer, pesticides, organic wastes, pathogens from pets, and other associated wastes from recreational activities.

Recreation Land Grading And Shaping (566)

Altering the surface of the land to meet the requirements of recreational facilities. This applies to areas where surface irregularities, slopes, kinds of soils obstructions and wetness interfere with the planned uses, and maintaining and improving habitat for fish and/or wildlife.

Recreation Trail And Walkway (568)

A pathway prepared especially for pedestrian, equestrian, and cycle travel. This provides users of recreational areas with travel routes for activities such as walking, running, bicycling, sightseeing, horseback riding, etc.. The practice should prevent erosion, preserve and protect soil, plant, animal and visual resources. Water quality issues such as nutrients and pathogens are taken into account.

Residue Management, No Till and Strip Till (329a)

Managing the amount, orientation and distribution of crop and other plant residues on the soil surface year-round, while growing crops in narrow slots or tilled strips in previously untilled soil and residue. This practice is a part of a Conservation Management System which benefits reductions in sheet and rill erosion, wind erosion, conserves soil moisture, manages snow to increase plant available moisture, reduces plant damages from freezing and/or desiccation, and provides food or escape for wildlife.

Residue Management, Mulch Till (329b)

Managing the amount, orientation and distribution of crop and other plant residues on the soil surface year-round, while growing crops where the entire field surface is tilled prior to planting. This practice is a part of a Conservation Management System which benefits reductions in sheet and rill erosion, wind erosion, conserve soil moisture, manages snow to increase plant available moisture, and provides food or escape for wildlife. This applies to chisel plowing or disking both on summer fallowed lands and annual or perennial planted crops.

Residue Management, Ridge Till (329c)

Managing the amount, orientation and distribution of crop and other plant residues on the soil surface year-round while growing crops on preformed ridges alternated with furrows protected by crop residue. This practice is a part of a Conservation Management System which benefits reductions in sheet and rill erosion, wind erosion, conserves soil moisture, manages snow to increase plant available moisture, modification of wet soil conditions, and provides food or escape for wildlife. This practice adapts well to banding of pesticides and nutrients thus reducing significant quantities subject to potential surface or ground water contamination. Weed pressures are controlled with a modified ridge builder/cultivator.

Residue Management (Seasonal) (344)

Managing the amount, orientation, and distribution of crop and other plant residues on the soil surface during part of the year from harvest until tillage occurs for the next years growing season. This practice is a part of a Conservation Management System which benefits reductions in sheet and rill erosion, wind erosion, conserves soil moisture, manages snow to increase plant available moisture, and provides food or escape for wildlife. This practice when managed properly will not contribute to water quality concerns.

Riparian Forest Buffer (391)

An area of trees and/or shrubs located adjacent to and up-gradient from water bodies. This practice can reduce excess sediment, organic materials, nutrients, pesticides, and other potential pollutants in surface runoff or into shallow ground water flow. It provides shade to lower the ambient water temperature to improve fish and other aquatic organisms, provides a source of detritus and large woody debris for fish and other aquatic organisms, creates habitat and corridors for wildlife, mitigates flood velocities, and flatten peak flows. This practice applies to stable permanent and intermittent streams, lakes, ponds, wetlands and areas with ground water recharge. Water quality will be enhanced from reduced levels of nutrients, pesticides, sediments (dissolved oxygen and water temperatures).

Row Arrangement (557)

Establishing a system of crop rows on planned grades and lengths primarily for erosion control and water management. This applies to areas where adequate drainage, soil erosion, or inadequate use of available rainfall or irrigation water exists. This is used as part of a Conservation Management System. Proper management will inhibit sediment, nutrient and pesticide movement.

Runoff Management System (570)

A system for controlling excess runoff caused by construction operations at development sites, changes in land use, or other land disturbances. This applies to proper planning, design, installation, operation, and

management of runoff to include adequate outlets and component practices. The plan includes a designed runoff rates and sediment controls from development sites during and after construction to minimize flooding, erosion and sedimentation thus having a positive impact on water quality.

Sediment Basin (350)

A basin constructed to collect and store debris or sediment where the primary purpose is to trap and store water-borne sediment and debris. This prevents undesirable deposition on low-lying areas and developed sites, reduces or abates pollution by providing storage space for sand, gravel, silt, stone, agricultural waste and other detritus so as to preserve capacities of reservoirs, ditches, canals, diversions, terraces, waterways, streams, wetlands, etc.. Aquatic ecosystems are enhanced greatly when properly operated and maintained. (Includes regularly scheduled cleanouts.)

Spoil Spreading (572)

Disposing of excavated materials from a grassed waterway, drainage ditch or an irrigation canal by spreading the surplus over adjacent land. Disposal of soil will be placed in adjacent surface depressions by shaping or spreading the spoil over the surface along the construction zone. Spreading spoil reduces sedimentation and allows revegetation of adjacent banks to aid in infiltration and filtering of surface runoff water contaminants.

Spring Development (574)

Improving springs and seeps by excavating, cleaning, capping, or providing collection and storage facilities to improve water distribution or to increase the quantity of water for domestic use, livestock, and wildlife. If suitable quantity and quality water exists, irrigation might be an applicable use along with a storage structure. Development of springs affords livestock producers another water source that allows these producers to remove and fence out surface water bodies. This move will enhance water quality by removing livestock manures and potential pathogens from entering the water source.

Streambank and Shoreline Protection (580)

Using vegetation or structures to stabilize and protect banks of streams, lakes, estuaries, or excavated channels against scour and erosion. These stabilization methods prevent loss or damage to roads, utilities, buildings, or other facilities, maintain channel capacities, control channel meanders that could adversely affect downstream or upstream land uses, reduce sediment loads to further damage downstream reaches, improve stream recreation, improve habitat for fish and wildlife, and provide safety to adjacent land users. Water quality improvements result mostly from reduced sedimentation. Prior to design or installation contact the local, state, or federal agencies that regulate permit activities in public waters.

Stream Channel Stabilization (584)

Stabilizing the channel of a stream with suitable structures to control stream channels undergoing aggradation or degradation that cannot be managed using clearing or snagging alone, establishment of vegetative protection or by installing upstream water control structures. Installation reduces sediment loads. Prior to design or installation contact the local, state, or federal agencies that regulate activities in public waters.

Strip Cropping (Contour) (585)

Growing crops in a systematic arrangement of strips or bands on the contour to reduce water erosion. The crops are arranged so that a strip of grass or close-grown crop is alternated with a strip of clean-tilled crop or fallow or a strip of grass is alternated with a close-grown crop. This practice reduces soil erosion and improves water quality and quantity. Water quality improvement is provided through improved infiltration thus reducing potential runoff water contamination from such sources as sediment, nutrients, and pesticides.

Strip Cropping (Field) (586)

Growing crops in a systematic arrangement of strips or bands arranged nearly perpendicular to the prevailing winds to reduce wind erosion. The crops are arranged so that a strip of grass or close-grown crop is alternated with a strip of clean-tilled crop or fallow or a strip of grass is alternated with a close-grown crop. This practice reduces soil erosion and improves water quality and quantity. This practice

increases snow catchment and reduces damage to crops from airborne abrasive soil particles. This practice will provide trap area for airborne sediments with attached nutrients and pesticides from entering surface water bodies.

Structure For Water Control (587)

A structure in an irrigation, drainage, or other water management systems that conveys water, controls the direction or rate of flow, or maintains a desired water surface elevation. This practice controls the stage, discharge, distribution, delivery, or direction of flow into open channels or water use areas. It is a practice used whenever a permanent structure is integrated into a Conservation Management System for irrigation, drainage, or other water-control systems to serve one or more of the following functions: 1) conduct water from one elevation to another within, to, or from a ditch, channel, or canal; 2) control elevation of water in drainage or irrigation ditches; 3) diversion or measurement of irrigation water; 4) keep trash, debris, or weeds seeds from entering pipelines; 5) control direction of channel flows resulting from back flow or high water from flooding; 6) control the level of water table or to remove surface or subsurface water from adjoining land, to flood land for frost protection or to manage water levels for wildlife or recreation; 7) provide water control for recreation or similar purposes; 8) to convey water over, under, or along a ditch, canal, road, railroad, or other barriers; 9) modify water flow to provide habitat for fish, wildlife, or other aquatic animals. This is not to be used in lieu of grade stabilization structures when for a head-cut control is the main function. Water quality may be improved provided the detention time for the collected surface water runoff is given ample residence time.

Subsurface Drain (606)

A conduit, such as concrete, clay, or corrugated plastic tubing, tile, or pipe is installed beneath the ground surface to collect and/or convey drainage water. This applies to areas having a high water table and benefits are received by lowering the water table; used in conjunction with other conservation practices to provide foundation stability; and has free flow by gravity or to a pumping system to make the practice cost-efficient. The practice provides an improved soil environment for improved vegetative growth; reduces soil erosion due to improved infiltration; intercepts seepage (ground water flows); regulates sub-irrigated areas; regulates waste disposal areas; removes water from heavy use or valuable assets such as buildings, play areas, roads, etc.; regulates water to control potential health hazards such as liver fluke, flies, or mosquitoes; and potentially improves water quality. Water quality may effect down stream water temperatures; visual quality; deliver dissolved substances (salts, nitrates, etc.) down stream, and sediment depending on whether the system is a closed or partially closed system. This system does not remove water soluble (inorganic or organic pesticides) when discharged into surface waters. This practice will be used according to NRCS wetlands policy.

Surface Drainage Field Ditch (607)

A graded ditch for collecting excess water in a field. It applies to shallow ditches installed to collect surface ponded water from a field with depressions; collect or intercept excess surface water such as sheet flow from natural or graded land surfaces or channel flows from furrows and carry it to an outlet; and collect and intercept excess subsurface water and carry it to an outlet. Generally this applies to flat and nearly flat lands with slowly permeable soils. This does not apply to "surface drainage, mains and laterals" or grassed waterways. This practice will be used according to NRCS wetlands policy.

Surface Drainage Main or Lateral (608)

An open drainage ditch constructed to a designed size and grade. This applies to ditches for disposal of surface and subsurface drainage water previously collected by field ditches and/or subsurface areas. It provides minimum drainage requirements for multi-purpose channels that provide outlets for agricultural lands. [This standard does not apply to surface field ditches or open channel standards.] The practices provides for safe removal; of excess surface and/or subsurface water, intercepts ground water flow; controls ground water levels; provides for leaching of saline or alkali soils or any combination. This practice will be used according to NRCS wetlands policy.

Surface Roughening (609)

Roughening the soil surface by ridging or clod forming tillage techniques to reduce wind erosion on cultivated lands, especially during periods of high probability for erosive winds. Areas with little to no

residue protection and soils capable of forming clods when tilled are most applicable. This practice should be used only in emergency situations. Water quality is improved when applied properly through reductions in air-borne sediments which may carry nutrients and pesticides from entering surface water bodies.

Terrace (Gradient) (600g)

An earth embankment, a channel, or a combination ridge and channel constructed across the slope. [This does not apply to diversions.] Terraces reduce the slope length; reduce soil erosion; reduce sediment loading in surface runoff water; improves water quality; intercepts and delivers surface runoff water in a non-erosive velocity to a stable outlet; retain soil runoff for moisture conservation; prevent gully development; reform the land surface; improve farmability; and reduce flooding down slope or adjacent low-lying lands. This is not applicable to lands with less than 1% slope. Terraces may be broad based, narrow based, or steep-back sloped cross-sections. Level terraces should be used only where the soils have a high infiltration rate so as not to damage crops or cause ground water contamination. Gradient terraces may use either under-ground tile outlets or vegetated surface water outlets such as diversion, grassed waterways, road ditches, etc.. Water quality is improved through reductions in sediment carrying nutrients, and pesticides that are delivered to surface and groundwater. Water soluble nutrients and pesticides may be partially reduced through increased infiltration and absorption.

Terraces (Storage) (600s)

An earth embankment, a channel, or a combination ridge and channel constructed across the slope. [This does not apply to diversions.] Terraces reduce the slope length; reduce soil erosion; reduce sediment loading in surface runoff water; improve water quality; intercept and deliver surface runoff water in a non-erosive velocity to a stable outlet; retain soil runoff for moisture conservation; prevent gully development; reform the land surface; improve farmability; and reduce flooding down slope or adjacent low-lying lands. This is not applicable to lands with less than 1% slope. Terraces may be broad based, narrow based, or steep-back sloped cross-sections. Level terraces should be used only where the soils have a high infiltration rate so as not to damage crops or cause ground water contamination. Water quality is improved through reductions in sediment carrying nutrients and pesticides delivered to surface and ground water. Water soluble nutrients and pesticides may be partially reduced through increased infiltration and absorption.

Tree or Shrub Establishment (612)

Establishes woody plants by planting or seeding. It is used for the purpose of developing forest products; protecting a watershed; providing wildlife habitat; providing erosion control; reducing water pollution through uptake of soluble nutrients and pesticides carried by sediments and/or runoff water; improving energy conservation and beautification and/or controlling snow drifting. Trees and shrubs provide soil stability to ephemeral gullies, riparian buffer zones, sinkhole treatment sites, etc. by being the first line of defense in catching surface water pollutants and anchoring the soil on the banks of various water bodies. Water quality will be enhanced through reduced loadings of sediment, pathogens, nutrients and pesticides to a receiving water body.

Trough or Tank (614)

A trough or tank, with needed devices for water control and waste water disposal, to provide drinking water for livestock. It applies to all tanks or troughs installed to provide livestock watering facilities supplied from a spring, reservoir, well, or other source. The proper placement will bring about the desired distribution of water to disperse livestock from critical or sensitive areas thus provide for more efficient utilization of forages and removal of animals from water bodies. Water quality is improved by reducing sediment, manures, pathogens, and nutrients entering the body of water and preventing herd health hazards.

Underground Outlets (620)

A conduit installed beneath the surface of the ground to collect surface water and convey it to a suitable and stable outlet. [This does not apply to principal spillways or subsurface drains of ponds.] This practice conveys excess water from terraces, diversions, or grassed waterways. Water quality is improved through sediment reduction, however, water soluble nutrients and pesticides will be piped directly to water bodies creating potential pollution problem.

Use Exclusion (472)

Excluding animals, people and or vehicles from an area not intended for grazing; to protect, maintain, or improve the quantity and/or quality of the plant, soil, air, water, aesthetics and animal resources; maintain adequate cover to protect the soil; and maintain or improve water quality. It is used in areas to protect woodlands, wildlife, streams, ponds, and other water bodies; soil hydrologic values from being damaged; and when animal, human health, or safety hazards are present. Water quality will be improved through reductions in sediments, pathogens, nutrients, and other soluble substances (hazardous or non-hazardous).

Waste Management System (312)

A planned system in which all necessary components are installed for managing liquid and solid manure, including runoff from concentrated manure areas, in a manner that does not degrade air, soil or water resources. This practice establishes the minimum accepted planning and operational requirements. [It does not apply to the design and installation of components.] It is used in rural areas in a manner that prevents or minimizes degradation of air, soil, and water resources while protecting public health and safety. Such systems are planned to preclude discharges of pollutants to surface or ground water and to recycle manure nutrients through soil and plants to the fullest extent practicable. This is a part of the Conservation Management system. Water quality will be improved through reductions in loadings of organics, pathogens, and nutrients into surface waters. When properly designed, managed, and maintained, surface and groundwater quality will not be impaired.

Waste Storage Pond (425)

An impoundment made by excavation or earthfill for temporary storage of animal manures or other agricultural waste. [This does not apply to waste treatment lagoons or storage structures.] This applies where 1) an overall waste management system has been planned; 2) waste is generated by agricultural production or processing; 3) storage is necessary to properly manage the waste; and 4) soils and topography are suitable for construction. Constructed ponds will meet or exceed DNR construction requirements to protect surface and ground water resources. This is a part of the Conservation Management system. Constructed ponds will meet or exceed DNR construction requirements to protect surface and ground water resources. This practice has little effect on the quantity of surface or ground water even though some water is used to mix, dilute, and assist in clean out. Water quality will be improved through reductions in loadings of organics, pathogens, and nutrients into surface waters. When properly designed, managed, and maintained, groundwater quality will not be impaired.

Waste Storage Structure (313)

A fabricated structure for temporary storage of animal manures or other organic agricultural wastes. [This does not apply to waste treatment lagoons or storage ponds.] This is used as a component practice for pollution-control and energy-utilization systems to conserve nutrients and energy and to protect the environment. This applies where 1) an overall manure management system has been planned; 2) manure is generated by agricultural production or processing; 3) storage is necessary to properly manage the manure; and 4) soils and topography are suitable for construction. This is a part of the Conservation Management system. Constructed structures will meet or exceed DNR construction requirements to protect surface and ground water resources. This practice has little effect on the quantity of surface or ground water even though some water is used to mix, dilute, and assist in clean out. Water quality will be improved through reductions in loadings of organics, pathogens, and nutrients into surface waters. When properly designed, managed, and maintained surface and groundwater quality will not be impaired.

Waste Treatment Lagoon (359)

An impoundment made by excavation or earthfill for biological treatment of animal manures or other agricultural waste. [This does not apply to waste storage ponds or structures.] This practice biologically treats organic wastes, reduces pollution potentials, and protects the environment. These lagoons are of three general types,: 1) naturally aerobic; 2) anaerobic; and 3) mechanically aerated. This applies where 1) an overall manure management system has been planned; 2) manure is generated by agricultural production or processing; 3) storage is necessary to properly manage the manure; and 4) soils and topography are suitable for construction. This is a part of the Conservation Management system. Constructed lagoons will meet or exceed DNR construction requirements to protect surface and ground water resources. This practice has little effect on the quantity of surface or ground water even though some

water is used to mix, dilute, and assist in clean out. Water quality will be improved through reductions in loadings of organics, pathogens, and nutrients into surface waters. When properly designed, managed, and maintained surface and groundwater quality will not be impaired.

Waste Utilization (633)

Using agricultural manure or other waste on land in an environmentally acceptable manner while maintaining or improving soil and plant resources. Agricultural manures and other wastes provide fertility for crops, forage, or fiber production; to improve or maintain soil structure; to aid preventing soil erosion; and to safeguard water resources. Where soil and vegetation are suitable for the use of manures and other wastes as a fertilizer, also municipal treatment plants and agricultural processing plants may supplement nutrients when properly planned and applied. This a part of the Conservation Management System. It must meet or exceed the minimum requirements of DNR land application regulations. Water quality will be improved through reductions in loadings of organics, pathogens, and nutrients into surface waters. When properly designed, managed, and maintained surface and groundwater quality will not be impaired.

Water and Sediment Control Basin (638)

A short earth embankment or a combination ridge and channel generally constructed across the slope and minor watercourses to form a silt or sediment basin. [This does not apply to diversions, grade stabilization structures, sediment basins, or terraces.] The maximum watershed is 20 acres for design purposes. This practice serves to trap and collect sediment in water; reduce peak rate of flow to downslope locations; reduce flooding; reduce gully erosion; reform the landscape; and improve potential of areas for farming. It applies where terraces are precluded due to significant water erosion and high sediment delivery. This practice is part of Conservation Management System. Water quality is improved significantly from sediment collection.

Well (Irrigated) (642i)

A well constructed or improved to provide water for irrigation. The practice is a part of a Conservation Management System. This applies to wells driven, drilled, and dug to supply water from an underground water source. [It does not apply to pumps, pipelines, troughs, and tanks.] This practice facilitates for proper cropland management by providing an adequate supply of water for conservation irrigation. Irrigation wells are limited to geologic sites where sufficient quantity and quality ground water is available for the intended land use, and the site is suitable for irrigation. All wells will comply with state water laws and regulations administered by DNR-DGLS and MDOH. Proper siting, design, installation, management and maintenance will insure proper well head protection to prevent potential ground water contamination.

Well (Livestock and Wildlife) (642l)

A well constructed or improved to provide water for livestock, wildlife, or recreation. This applies to wells driven, drilled, and dug to supply water from an underground water source. [It does not apply to pumps, pipelines, troughs, and tanks.] This practice facilitates proper use of vegetation on range, pastures, and wildlife areas; to supply water requirements of livestock and wildlife; and to provide for human use at recreation sites. Wells are limited to geologic sites where sufficient quantity and quality ground water is available for the intended land use and the site is suitable for the intended use. All wells will comply with state water laws and regulations administered by DNR-DGLS and MDOH. Proper siting, design, installation, management and maintenance will insure proper well head protection to prevent potential ground water contamination.

Well Decommissioning (351)

The sealing and permanent closure of a well no longer in use or inadequate to meet current water needs. This practice serves to prevent entry of vermin, debris, or other foreign substances into the well or well bore hole; eliminate the physical hazard of an open hole to people, animals, and farm machinery; prevent entry of contaminated surface water into well and migration of contaminants into unsaturated (vadose) zone or saturated zone; prevent entry of commingling of chemically or physically different ground waters between separate water bearing zones. This practice applies to any drilled, dug, driven, bored, or otherwise constructed vertical water well determined to have no further beneficial use. It does NOT apply to wells that were used for illegal waste disposal and are contaminated. All wells closed must follow all state and federal laws and regulations regarding closure.

Wetland Restoration (Interim) (657)

The construction or restoration of a wetland facility to provide the hydrological and biological benefits of a wetland. This practice applies to both structural and non-structural facilities as needed to establish or restore wetlands. Wetlands provide wildlife benefits; reduce flooding; provide off-site water quality benefits; and provide ground water recharge of acceptable water quality. This applies to natural wetlands that were drained or sites that are capable of storing water for the development of a wetland community

Wildlife Upland Habitat Management (645)

Creating, maintaining, or enhancing areas, including wetlands, for food and cover for upland wildlife. This practice will create, maintain, and enhance suitable habitat by sustaining desired upland wildlife game and non-game species. Specific habitat requirements are found elsewhere. Water quality may be impacted from sediment during the initial development stages but gradually declining for a net gain in improved control of erosion and sediment.

Wildlife Water Facility (648)

Constructing, improving, or modifying watering places for wildlife so as to provide quality and quantity of drinking water. This practice is used to increase specie range of adaptation and improve the habitat for multiple species. Sites are located close to wildlife escape cover. Areas are fenced to protect from cattle watering sites. Structures can include dugout, embankment ponds, springs, seeps, or small tributaries.

Wildlife Wetland Habitat Management (644)

Retaining, creating, or managing wetland habitat for wildlife in order to retain, create, or improve wetland habitat for waterfowl, furbearers, and other wetland wildlife. Wetlands can also be designed for water quality benefits for removal of sediment, nutrients, and pesticides; commercial and industrial waste plus domestic septage treatment. Wetlands are generally impounded and maintained by diking, ditching, flooding, or pumping.

Windbreak/Shelterbelt Establishment (380)

Linear plantings of single or multiple rows of trees or shrubs established for environmental purposes. These purposes include but are not limited to one or more purposes such as 1) reduce soil losses from wind erosion; 2) protect growing plants; 3) improve soil moisture and water conservation; 4) improved irrigation efficiency; 5) manage snow drifting; 6) provide shelter for livestock and wildlife; 7) provide wildlife habitat for game and non-game species; 8) provide living screens; 9) improve aesthetics; 10) ameliorate excessive noise; and 11) improve energy conservation. Water quality is improved through reduced soil particle deposition into surface water bodies along with other potential air-borne contaminants such as nutrients, organic matter, and pesticide. Protected areas show an increase in infiltration and soil moisture due to decreased evaporative demand. Feedlot runoff from snow melt has the potential for establishments catching detached soluble nitrates, phosphorous, pathogens and other organic substances.

Woodland Pruning (660)

Removing all or parts of selected branches from trees to improve the quality of the wood product(s) and appearance of the trees. It is used where the quality of the product is enhanced or it corrects deformities or broken branches, corrects for safety or health, and Christmas or other ornamentals. This practice will not have a significant water quality benefits unless pests are the cause of this activity.

Woodland Site Preparation (490)

Treating areas to encourage natural seeding of desirable trees or to permit reforestation by planting or direct seeding. This is used to prepare a site for conducive establishment of trees while conserving soil and water; improving watershed protection; enhancing wildlife habitat; and production of forest products. It is adaptable to stocking under stocked areas, areas with undesirable species or other vegetation or cropland that are suitable for growing trees. Water quality may have a short period of slight degradation resulting from sediment, nutrients, and pesticides followed by significant improvements depending upon the sites previous history.

CONSERVATION PRACTICES COMBINED WITH REVISED PRACTICES

Animal Trails and Walkways (575)
Grass and Legumes (Rotation) (411)
Proper Grazing Use (528)
Proper Woodland Grazing (530)
Vertical Drain (630)
Windbreak Renovation (650)
Woodland Improved Harvest (Final) (654f)

REFERENCES

Standards and Specifications, Section IV, **Electronic** Field Office Technical Guide (eFOTG),
USDA-Natural Resources Conservation Service (NRCS), Missouri.

Access eFOTG at:

<http://www.nrcs.usda.gov/technical/efotg> Click on Missouri on the U.S. Map.

SILVICULTURE

The following information is condensed from the original document, “A Final Report on Missouri Silvicultural and Watershed Protection Practices,” produced by the Silvicultural and Watershed Protection Practices Committee, 1987, convened and chaired by the Missouri Department of Conservation. The changes include updating the forest inventory data and adding information about preharvest planning and silvicultural practices used in forested wetlands. Additional data is included about sedimentation and pesticide use. The attached matrix, Table 8, presents a quick reference describing the various silvicultural practices and the agency through which technical, mechanical, and financial assistance is available. Table 8 is presented at the request of DNR and is not discussed in this summary or in the final report.

Forest Cover

Forestland acreage in Missouri is estimated at 15 million acres or 34 percent of the total of 44.3 million acres of land. This is a gain of about 8.9 percent from the 1972 Forest Inventory (Spencer). About 627,000 acres are reserved as wilderness acres and parks. About 14.6 million acres is defined as commercial forestland, or timberland, which has the capacity to grow commercial volumes of wood products (Hahn 1989). Approximately 83 percent or 12.2 million acres of the commercial forestlands are privately owned by farmers and other individual owners. Over 145,000 acres of timberlands is owned by the forest products industry. About 1.321 million acres are under the management of the U.S. Forest Service, with about 246,000 acres in other federal lands including Ft. Leonard Wood. The remaining 615,000 acres compose forested state Conservation Areas. Most private commercial forest land is owned by farmers and other individuals. These ownerships are generally small and managed for a variety of objectives, including periodic income from the sale of timber, recreational uses, aesthetics, woodland pasture and other considerations. Results of the 2000 inventory of Missouri show a slight increase in the area of forestland. While forestland area continues to increase, the rate of conversion from other land uses to forestland has slowed. It appears that in the 11 years between inventories (1989 to 2000), the area of forestland increased by approximately 8%. (Missouri Forest Resources in 2000): http://www.ncrs.fs.fed.us/pubs/rn/rn_nc375.pdf.

The Forest Products Industry

The Missouri forest products industry makes a significant contribution to the state's economy. The annual harvest of Missouri timber is estimated at over 709 million board feet of saw timber, stave bolts, veneer logs and posts on the International 1/4-inch basis (Piva and Jones, 1994). More than 33,000 persons are employed by the forest products industry. Value of the wholesale product is estimated at \$2.7 billion annually (Devino, 1993 and MDC, 1995). The value paid to Missouri landowners and agencies for forest products is estimated at over \$109 million annually (Jones, 1997).

Silvicultural Practices Used or Recommended in Missouri

By definition, silvicultural practices are directed toward the creation and maintenance of a forest that will best fulfill the objectives of the owner (Smith, 1962). Cutting trees in a forest as part of a land use change, as in the conversion of forest to pasture, cropland, non-forested wetland, urban expansion or another non-forest use, is not a silvicultural practice.

More detailed descriptions of silvicultural practices are provided in the technical report. A listing of the harvesting practices used in the evenaged (harvesting most trees at one time so that the next generation of trees are mostly the same age) forest management system include: clearcutting, shelterwood, seedtree, intermediate harvest and precommercial thinning. Harvesting practices used in the unevenaged system include the selection method and modifications of the selection method. Both the evenaged and unevenaged system accomplish growing and naturally regenerating the forest in perpetuity. Other silvicultural practices include preparation of sites for a new forest either through planting of seedlings or use of direct seeding to artificially regenerate a forest or to accomplish reforestation on lands that are currently in nonforest use.

To some extent, silvicultural practices do affect water quality. However, the effects are of relatively short duration, three to seven years, are often difficult to detect and usually cause no permanent degradation of beneficial water uses. Use of forested buffer strips, which separate the silvicultural activity from lakes and streams, are an important method to reduce the impacts of sedimentation. Additionally, buffer strips help to moderate water temperature, decrease sediment and nutrient transport, and trap pesticides before they enter the water. Timber harvests, the most common silvicultural activity, occur infrequently on small areas and amount to about two percent of Missouri's commercial forest land acreage annually. They do not require extensive road construction for access, and rapid vegetative growth response stabilizes exposed soil quickly.

Site preparation for establishment of natural and artificial forest reproduction is done using bulldozers, brush hogs, hand tools, chemicals, or prescribed fire. Bulldozing is the most disruptive type of site preparation, but is limited to small areas because of expense. Brush hogging and the use of hand tools leaves vegetation that protects the soil. The use of chemicals is limited to small areas, where the chemical is less likely to move off the treated site. Prescribed fire is performed under close supervision when carried out on public lands.

Timber stand improvement (TSI) refers to a family of practices used to free selected trees for further growth. TSI is done mechanically or with chemicals to remove undesirable trees. TSI is done on a stand by stand basis, usually a small area up to approximately 25 acres, with little soil disturbance and performed so chemicals remain on the site.

Silvicultural Activity Effects on Water Quality

The following is a brief discussion about water quality indicators and the impacts of silvicultural operations.

Temperature

In the southeastern United States, ambient water temperature maxima in forested watersheds are assumed to be about 85°F. In small streams, water temperature increases of 6°F to 13°F have been documented following regeneration harvests lacking buffer strips. When buffer strips were used, water temperature increases were reduced to 1°F to 8°F above ambient. Water temperature ranges returned to normal levels within three to five years as regrowth of vegetation began shading the soil (Wigington, 1985). Benthic organisms react directly and indirectly to temperature increases. Some benthic populations decrease while others increase as stream

temperature rises. Stoneflies (Plecoptera) are highly sensitive to temperature increases. However, in general, most species of benthic organisms are not directly effected, as long as temperatures did not increase over 86°F during the day (Walsh 1992).

Missouri's water quality standards set maximum temperatures of 90°F for most waters, 84°F for certain Ozark rivers designated as cool water fisheries and 68°F for areas below large springs designated as cold water fisheries. The potential for exceedence of temperature standards would appear to exist. Very extensive harvests might cause water quality exceedances in some of the smaller classified streams, but typically sized harvests in Missouri should not cause exceedence of temperature standards in classified waters.

Dissolved Oxygen

Silvicultural activities should not cause dissolved oxygen levels to drop below water quality standards in lakes or flowing streams. The Missouri standard for dissolved oxygen states effluent shall not cause dissolved oxygen to be lower than 5 mg/liter in classified streams and 6 mg/liter in cold water sport fisheries. Dissolved oxygen levels are related to temperature fluctuations and abundance of nutrients. Dissolved oxygen ranges from approximately 11.3 ppm at 50°F to 7.6 ppm at 86°F for stream water emerging from harvested areas (seasonal temperature range measured during the study) (Wiggington, 1985). The fluctuation of dissolved oxygen levels is related to the increase in decomposition rates of plant nutrients as temperature increases. Use of buffer strips minimizes temperature fluctuations. However, apart from short-lived effects in small streams in areas that naturally experience high summer isolation, there is no evidence of a major effect of logging on salmonids from low dissolved oxygen concentrations (Meehan, 1991).

Nutrient Losses

Available data do not indicate any large detrimental increase in dissolved nutrient concentrations in stream flow as a result of silvicultural activities. Nitrate concentrations of 0.83 mg/l are documented in the stream flow of a Missouri watershed after harvesting. Nitrate concentrations in water samples from a buffer strip are approximately 0.4 milligrams per liter. In all study cases, concentrations have remained below the drinking water standard of 10 ppm for nitrates. Studies in Missouri have documented that forested areas release less nitrogen to streams than other land uses. Smart (1980), found water chemistry strongly correlated with land use in the Missouri Ozarks with forested watershed streams averaging 0.005 mg/l nitrate-N and pastured streams 0.716 mg/l. Skadeland (1992), doing similar work in northeastern Missouri, found forested watersheds produced less nitrogen than typical land uses. Sensitive species of benthos can survive in water with a heavy organic load if the water is adequately reoxygenated by riffles. Benthic sampling above and below harvest sites indicate no change in biological richness. Streams free of sewage and fertilizers tend to be capable of processing nitrates and phosphates found in natural levels including nitrates and phosphates occurring in conjunction with forest harvesting (Walsh, 1992).

Turbidity

Missouri water quality standards state there shall be no color that will cause substantial visible contrast with natural appearance of the stream or lake or interfere with its beneficial uses (DNR 1992).

Water flowing through stream calibration equipment prior to forest harvesting indicates turbidity levels of 0.3 to 20 NTU (Nephelometric Turbidity Units), representing essentially pristine levels of water quality. Following a harvest, turbidity levels ranged from 0.6 to 42 NTU on harvests using buffer strips while harvesting without buffer strips resulted in turbidity levels ranging from 0.8 to 69 NTU. (Lawson, 1985, Mussallem, no date, Settergren, 1980). Harvesting does impact benthic life with sediments and cause some low-level turbidity. Increased levels of turbidity, associated with harvesting activities, appear to be associated with peak storm flow events. Young-of-the-year fish subjected to elevated turbidity grew less than those living in clear water causing more fish to migrate from their initial territory (Filipek, 1993). Fish species are variable in sensitivity to sedimentation and increases in turbidity. Trout, smallmouth bass and rock basses, some darters and madtoms are more sensitive than creek chubs and green sunfish. The decrease in the population of northern pike related to turbid water can cause an increase in the population of suckers, a primary forage fish (Filipek, 1993). High levels of turbidity may occur immediately following timber harvesting, but sediments settle quickly. The sediment may smother some benthic species while benefiting others. However, the increased flow in riffles are able to clear the cobbles and gravel of sediment thus providing a healthy benthic habitat (Walsh, 1992). As the forest regrows following a harvest, turbidity levels return to a normal level. Use of buffer strips should be promoted to allow deposition of sediments prior to reaching streams.

Suspended Solids

Following harvesting and site preparation treatments, suspended solid concentrations increase significantly during peak stormflow conditions. As the peak stormflow passes, suspended solid concentrations decline to normal flow levels. Over a three- to five-year period, levels of suspended solids return to a preharvest condition. Peak stormflow occurs for a short time depending upon rainfall rate, duration, and soil moisture content (Settergren, 1980, Miller, 1985, and Patric, 1984). However, as the size of the harvest area increases and the intensity of forest harvesting increases, suspended solids concentrations will also increase (Wehnes, 1995, Patric, 1994). There is a gap in the knowledge of the effects of dissolved and suspended solids on freshwater aquatic communities. Suspended solids have a significant effect on community dynamics when they interfere with light transmission. However, relatively high suspended solid levels, in excess of 20,000 mg per liter, were needed to cause behavioral reactions. Additionally, fish react to increased presence of suspended solids by avoidance, causing instability in some communities (Sorensen, 1977). Short-term exposure to high levels of suspended solids probably does not impede reproductive movements of most warmwater fishes, but chronic exposure could disrupt reproductive behavior (Muncy, 1979). Use of watershed protection practices can reduce levels of suspended solids as vegetation becomes established.

Sediment

Sediment movement is related to the amount of soil disturbance, percentage of the area utilized by the road system, soil type, slope, slope length, amount of rainfall, and other factors. Generally, sediment yields the first year following timber harvest are increased. However, there

is little scientific evidence that sediment generated by silvicultural activities has interfered with beneficial water uses in Missouri. Once the silvicultural treatment is completed, vegetative growth and leaf fall begin to stabilize soil movement on the area. Within a three- to four-year period, sediment yield returns to pretreatment levels (Blackburn, 1985, Lawson, 1985, Patric, 1980, and USEPA, 1993). Analyses of sediment yields on forest land nationwide, for both undisturbed and harvested forest land where BMPs are both used and excluded, show approximately 25 percent of the studies denote yields of about 0.02 tons per acre per year; 75 percent of the studies did not exceed 0.25 tons per acre per year and about 9 percent of the studies, exceeded 1 ton per acre per year (Patric, 1994). Sediment production from uncut eastern hardwood forests ranges from 0.05 to 0.1 tons per acre per year (Patric, 1994 and Scoles, 1994). Sedimentation following clearcut harvesting in the Ouachita Mountains of Arkansas with no BMP is documented at 0.106 tons per acre; a similar study in Oklahoma resulted in 0.126 tons per acre for the first year following harvesting (Scoles, 1994). Selection method harvesting in the Ouachita Mountains resulted in 0.017 tons per acre the first year following harvesting (Scoles, 1994). Clearcut harvesting, using BMP, can result in a 0.019 to 0.025 tons per acre annual soil loss while clearcutting with no BMP resulted in 0.04 to 0.27 tons per acre annual soil loss in a Pennsylvania study (Mussallam, 1980). The sedimentation rate may double during periods of maximum flow for a period of two- to three-years as the regrowth of the forest intercepts and transpires increasingly more water (Patric, 1994). Water quality information from shelterwood and intermediate harvests are not described. Shelterwood and intermediate harvests are expected to respond similarly to selection method harvests as a high percentage of the forest canopy remains following the harvest and a high percentage of the soil on the harvest area is not exposed.

Salmonid fry survival decreases up to 3.4 percent for each one percent increase in fine sediment and 97 percent of northern pike eggs died when covered with one millimeter of sediment (Filipek, 1993). Water movement across riffles clears the cobbles and gravel of some sediment.

Introduction of sediment alone and sediment treated with triphenyl phosphate, a chemical found in PCB substitutes and hydraulic oil, were introduced to two streams and a control. Sediment impact on benthic life was monitored. Although sediments altered drift patterns and percentage of similarity of benthic invertebrate communities, total numbers, number of species, and diversity of benthic invertebrates were not altered. Treatment with sediment and sediment treated with triphenyl phosphates resulted in increased nutrient retention, reduced algal export, and increased production of rooted flora. Leaf decomposition rates and patterns of emergence were not affected by either treatment (Fairchild, et al, 1987). Substantial evidence exists indicating the reproductive behavior of warmwater fishes is variously affected by sediment and suspended solids depending on the time of spawning. Fishes having behavior that protects the eggs from sediments have a reproductive advantage to those more sensitive to sediments (Muncy, 1979).

Nearly 90 percent of the erosion from timber harvesting is traced to the logging road system which is estimated at approximately 17 tons per acre per year (USEPA, 1993). The extent of soil loss is dependent on precipitation amounts, the type of road surface, the grade of the road, length of the road segment between breaks in the grade designed to drain water from the road surface, and the cut and fill used in construction of the road. For most harvesting operations in Missouri, the construction of logging roads is not required for access to the forested tract. In most cases

the main haul road from a timber sale is the country or state government- maintained gravel or hard-surface road system. Haul roads typically utilize existing forest and farm trails. In some cases these trails are improved for vehicle access. Use of forested buffer strips, road construction techniques and other watershed protection practices helps to reduce the impacts to lakes and streams resulting from road building operations. Forest practices do result in sedimentation, which is generally confined to the road system. As the forest grows following a harvest, the sedimentation levels continually decrease over a two- to five-year time span to pre-harvest sedimentation levels.

Fertilizers

Fertilizer use in Missouri for silviculture is virtually non-existent. Except for cases when fertilizer is used in reclamation, tree planting on mining spoils, research projects, nursery operations, and on urban trees, it is not used as a large-scale forestry management practice.

Pesticides

Pesticides used in Missouri silvicultural systems are applied occasionally to small acreage, at low application rates. As long as pesticides are not applied directly to streams or lakes, and a filter strip is used to trap movement of pesticides, there is usually little impact from properly applied pesticides used in silvicultural applications. Herbicides, the most frequently used pesticide, are subject to microbial degradation and inactivation when soil contact occurs.

Soil characteristics, including infiltration capacity, depth to bedrock, organic matter content, clay content, microbiological activity, structure and texture affect the transportation of the herbicide on and off the site (Neary, 1986 and Norris, 1981). Vegetation uptake, degradation, and recycling of herbicide residues can be a key process in herbicide utilization. Herbicides with the highest water solubilities, most resistance to physical, chemical and biological degradation, lowest affinities for absorption onto organic matter, and high application rates have the greatest potential for movement in the environment (Neary, 1986 and Norris, 1981).

All herbicides recommended for use in forest management activities in Missouri are registered and must be applied according to the directions on the label. Few private landowners use herbicides in silvicultural applications without the assistance of professional foresters. Herbicides are used when they are the most efficient method available and will not cause damage to the environment.

Fungicides and insecticides are rarely applied on forest land in Missouri to date. However, the gypsy moth invasion into Missouri is monitored closely. Currently the gypsy moth, a defoliator of hardwoods, has been reported colonizing in counties of Arkansas that neighbor Barry, Taney, and Stone counties in southwestern Missouri, a popular recreation area. The situation is closely monitored by the Missouri Departments of Agriculture and Conservation. Should controls become necessary, low impact insecticides and biological controls are available. An invasion of the gypsy moth can impact water quality through nitrification traced to dropping and frass accumulation in streams and lakes. The principal species of Missouri's forests are oaks and hickories which are prime candidates for gypsy moth defoliation (Burks, 1993).

Fire Retardants

Fire retardants are a family of chemicals used to aid construction of fire line. Retardants can be applied as liquid or foam. Use of water on wildland fire control is limited because of difficulty obtaining the quantities necessary for controlling the wildfire. The purpose of a fire retardant is to modify the surface tension of water and extend its effectiveness. Most uses of fire retardants occur in the western states. In Missouri, fire retardants are utilized on a limited extent in pickup truck-mounted water tanks in use by MDC and Forest Service fire crews. Water quality problems only exist from the use of fire retardants if the chemicals are applied directly to a lake or stream.

Methods for Reducing Nonpoint Source Pollution

Correctly applied silvicultural practices usually result in minimal, short-term pollution. In relation to land treated by agricultural practices, the amount of soil lost, frequency of soil disturbance, amount of chemicals used, and the acreage treated in silvicultural operations are small scale. However, on site-specific cases some incorrectly applied silvicultural practices can be problematic. Training should be offered to landowners, logging companies, and foresters to ensure watershed protection practices are correctly installed and the effectiveness of these practices monitored.

The influence of mechanized logging equipment on forest management on private lands in Missouri is unknown. Sales of previously unmerchantable wood from the stem and tops of trees will provide an additional source of income for some landowners. Whether the net effect will be to stimulate better management of private woodlands for improved timber resources remains to be seen. The presence of mechanized logging equipment should be seen and used as an educational opportunity to create and maintain a forest that will best fulfill the objectives of the forest landowner.

The following information describes watershed protection practices that can be effective when voluntarily used on silvicultural activities. In controlled studies, these practices tend to reduce the nonpoint source pollution resulting from silvicultural practices.

Pesticide use is regulated through certification of foresters and chemical applicators by the Missouri Department of Agriculture. Chemicals should be used, their containers disposed of and application equipment cleaned according to the chemical label directions. Careful use of chemicals and the use of protective buffer strips along streams should prevent prolonged or serious water quality degradation when used on timber stand improvements, in site preparation, and for weed control on reforestation projects.

Erosion from site preparation can be reduced by practices that minimize soil cover disturbance, including piling brush in wind rows along contour lines, leaving adequate filter strips along streams to trap sediment, and seeding of selected herbaceous vegetation to quickly establish ground cover in addition to the tree crop.

Erosion prevention from road and skid trail construction and use should be carefully planned. Watershed protection practices which have been implemented involve the following:

1. Minimize the total area of disturbance.
2. Restrict roads from steep grades, unsuitable soils, and buffer strips.
3. Provide for road surface protection with the use of gravel, if necessary.
4. Stabilize cut and fill banks with vegetation and brush barriers.
5. Provide for necessary road drainage by using culverts or out sloping with broad base dips.
6. Stabilize the roadbed by constructing water bars, stopping vehicle travel, and seeding the roadbed with grass following the operation.
7. Log when soil moisture content is favorable to avoid rutting.
8. Locate log loading areas on stable, adequately drained soils and so skidding of logs is directed away from streams.

Recommendations

The landowner is ultimately responsible for the cost of using watershed protection practices directly or indirectly through lower stumpage prices (Cubbage, 1987 and McKensey, 1987). It is in the interest of the landowner and industry to use the best available technical information during harvesting activities to maintain long-term productivity of soil forest resources. We can predict a reduction of nonpoint source pollution through the use of watershed protection practices. Voluntary use of these practices should be accompanied by a program that provides educational information to forest landowners, loggers, and foresters. Emphasis should be on the importance of clean water and steps that are effective in ensuring the continued production of clean water from Missouri's forests. Program direction should be provided through a team effort consisting of the following government agencies and representatives of the private business community: Missouri Department of Conservation, Forestry Division, Department of Natural Resources, Water Pollution Control Program, USDA Natural Resources Conservation Service, USDA Forest Service Mark Twain National Forest, University of Missouri School of Natural Resources, Missouri Consulting Foresters Association, and Missouri Forest Products Association.

Table 8 provides quick reference information about silvicultural activities and watershed protection practices. Included are advantages and disadvantages of using the watershed protection practices and the availability of technical, mechanical, and financial assistance through government agencies. This information is provided as requested by the Water Pollution Control Program and is not discussed in this summary or in the final report.

An additional resource for information on methods of reducing nonpoint source pollution from silvicultural operations "Missouri Watershed Protection Practices" is available without charge from the Department of Conservation. Published in 1997, the booklet contains management guidelines for maintaining forested watersheds to protect streams.

http://www.conservation.state.mo.us/documents/forest/private/forest_manag.pdf 2003 Ecopsy of the "Forest Management for Missouri Landowners, MDC, 2003

SILVICULTURAL AND WATERSHED PROTECTION PRACTICES

Table 11

PRACTICES	ADVANTAGES	DISADVANTAGES	AGENCY	ASSISTANCE AVAILABLE		
				TECHNICAL	MECHANICAL	
Site Preparation	Preparation of seedling and planting sites.	High degree of soil disturbance.	NRCS MDC DNR	E,G E,G E,G		CS CS
Tree planting on slopes	Reduces soil erosion. Provides sediment trap/nutrient filter for upland areas.	Hand plant or machine plant on contour on steep slopes to avoid gully erosion.	MDC	E, G	Tree planter	SIP
Establish adequate filter strips along streams	Traps sediment and pesticides, reducing the amount entering the stream. Reduces temperature of runoff water. Prevents streambank and channel erosion.	None	MDC, NRCS DNR	E,G E,G E,G	Tree Planter and tree marking	SIP CS CS
Land use conversion to forest	Erosion control and Streambank stabilization	None	MDC NRCS DNR	E,G, E,G E,G	Tree Planter	SIP CS CS
KEY: E = Education, G = Guide sheets and information, CS = Cost Share, MDC = Missouri Department of Conservation, DNR = Missouri Department of Natural Resources, NRCS = USDA Natural Resources Conservation Service, SIP = Stewardship Incentive Program						

SILVICULTURAL AND WATERSHED PROTECTION PRACTICES						
Table 11 cont'd.						
PRACTICES	ADVANTAGES	DISADVANTAGES	AGENCY	ASSISTANCE AVAILABLE		
				TECHNICAL	MECHANICAL	FINANCIAL
Preharvest planning for road system.	Minimize stream crossings. Reduce area of road system.	None	MDC	E,G	None	SIP--Can be covered in the farm management
Locate roads to minimize the total area of disturbance.	Reduces compaction and erosion from the harvest area. More area for growing trees.	None.	MDC	E, G	None	None None
Use gravel to protect road surfaces where necessary.	Reduces soil erosion and rutting from the road surface.	Increases road building costs.	MDC	E, G	None	None
Stabilize cut and fill banks with vegetation and brush barriers.	Reduces sediment movement from cut and fill banks.	Increases road building costs.	MDC	E, G	None	None
Provide road drainage using culverts and water turn out diversions.	Provides water drainage and reduces erosion from the road surface. Allows continued use of roads during wet weather.	Increases road building costs.	MDC	E, G	None	None
KEY: E = Education, G = Guidesheets and information, CS= Cost Share, SIP = Steward Incentives Program, MDC = Missouri Department of Conservation, DNR = Missouri Department of Natural Resources, NRCS = USDA Natural Resources Conservation Service						

SILVICULTURAL AND WATERSHED PROTECTION PRACTICES

Table 11 cont'd

PRACTICES	ADVANTAGES	DISADVANTAGES	AGENCY	ASSISTANCE AVAILABLE		
				TECHNICAL	MECHANICAL	FINANCIAL
Seed truck loading areas with grass or plant trees after harvest is completed.	Reduces erosion and provide wildlife habitat.	Limited amount of sunlight available on some sites.	MDC NRCS	E,G E,G	None	None
Provide road drainage by out-sloping the road and using broad base dips.	Provides water drainage and reduces erosion from the road surface. An alternative to use of culverts on seldom used roads.	Requires some rock surfacing and care used to ensure proper out sloping of the road.	MDC NRCS	E,G E,G	None	SIP --Covered in the farm management plan
Close the road after logging is finished. Stop vehicle traffic, seed the road bed, construct water bars as needed.	Reduces erosion from the road bed. Protects the road for future use.	Increases road building costs.	MDC	E,G E,G,CS	None	SIP
Woodland protection from livestock.	Reduces erosion and trampling of tree seedlings.	None	MDC DNR NRCS	E,G E,G E,G	None	SIP CS CS

E = Education, G = Guide sheets, informational material, videotapes, etc., CS = Cost Share,

SIP = Stewardship Incentive Program,

MDC = Missouri Department of Conservation,

DNR = Missouri Department of Natural Resources,

NRCS = U.S. Department of Agriculture, Natural Resources Conservation Service

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CONSTRUCTION

Characterization

Construction activities occur in every county of Missouri. These construction sites range from a two car garage and driveway to highways, roads and bridges to 100+ lot multi-phase subdivision projects. If construction activity disturbs more than one acre of land over the life of the project a Missouri State Operating Permit for stormwater discharges is required. However, there is no reliable way to tell how many construction sites that disturb less than one acre are active in the state. Sites where disturbance is less than one acre are not regulated under the stormwater laws. These small construction sites can range from small subdivisions and single-family homes to agricultural terraces and farm ponds. All sites, regardless of size, have the potential to contribute to nonpoint source pollution if sound best management practices aren't implemented.

A total of 2390 land disturbance permits have been issued between the year 2000 and November 17th, 2003. This "land disturbance" permit is called a National Pollutant Discharge Elimination System (NPDES) permit.

(EPA NPDES website): http://cfpub.epa.gov/npdes/contacts.cfm?program_id=6&type=ALL.

Missouri has regulated stormwater discharges since October 1992 (RSMo 10 CSR 20-6.200 Stormwater Regulations). Rules of the Department of Natural Resources, Division 20 Clean Water Commission - Chapter 6- Permits, was updated and promulgated in 2003 and can be viewed in its entirety at the following link: <http://www.sos.mo.gov/adrules/csr/current/10csr/10c20-6a.pdf>
Information on specific NPDES permits can be viewed at the following website:
<http://www.dnr.mo.gov/wpscd/wpcp/permits/wpcpermits-stormwater.htm>

The land disturbance permits require the use and maintenance of erosion and sediment control measures sufficient to prevent the movement of sediment off-site. Stormwater pollution prevention plans for construction activities are required to be developed before the issuance of a land disturbance permit.

The Missouri Department of Natural Resources approves erosion control programs for municipalities, counties and government agencies interested in designing and implementing their own erosion control plan. This program can cover all of the land disturbance done for or by a city, county or government agency with an approved plan or can be expanded to cover all land disturbance of more than one acre within the jurisdiction of an entity with an approved erosion control plan.

Impacts

Sediment washing from all sizes of construction sites, both above and below the current one acre permitting threshold, can have severe impacts on lakes and streams. Because of the tendency for developers to grade the entire site at one time, then develop the site in phases, large tracts of land can be laid bare for many months, if not years. The amounts of sediment coming off these sites can range from 100 to 200 tons per acre per year.

Because of the difficulty in separating the sediment coming from construction sites from that of natural weathering and other background sources, the intensity of sedimentation in the stream from any individual construction site is very difficult to quantify. However, it can be estimated at the site by using the Universal Soil Loss Equation, which is a standard approach for estimating soil loss.

Sediment suspended in lakes can affect the growth of aquatic plants by reducing the sunlight available to them. High concentrations of sediment (above 20,000 ppm) can cause mortality in adult fish by clogging gills and reducing oxygen intake (Welsh, 1992), while lower concentrations (1,000 ppm) have been associated with chronic effects on aquatic ecosystems such as altered invertebrate drift pattern, increased nutrient production, reduced algal export and increased production of rooted flora (Fairchild et. al., 1987). Sediment deposition in streams and lakes can affect bottom dwelling fish and aquatic insects and disrupt normal reproduction in fish by covering spawning grounds. Large sediment deposits can fill stream channels and flood plains increasing the potential for flooding.

Sediment also carries other pollutants such as hydrocarbons, pesticides, fertilizers and other construction chemicals as it migrates into stream channels and other water bodies.

Best Management Practices (BMPs)

Best management practices for land disturbance are listed following the urban/suburban stormwater runoff section in this appendix. The first and by far the most effective best management practice is site planning. Careful site planning can eliminate many potential erosion and sedimentation problems by preventing them from occurring in the first place. Site planning can take into account the various slopes, soil types, drainage patterns and other variables and work out a site plan that will be compatible with the proposed land use.

Project phasing is another excellent best management practice. The phasing of a project can keep large areas from being graded and laying unstabilized for months if not years. By careful planning, only the phase that is being developed will be disturbed and unstabilized at any given time.

There is a wide range of BMPs available for erosion and sediment control. These practices can be vegetative, structural or a combination of both. Each site is unique, so it is difficult to establish BMPs that will work in every situation. Careful planning and the development of a storm water pollution prevention plan for construction activities can go far in establishing the types and combinations of BMPs that will be effective in controlling erosion and sedimentation from any given construction site.

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URBAN/SUBURBAN STORMWATER RUNOFF

Characterization

Urban stormwater runoff carries a myriad of pollutants directly and indirectly to Missouri's streams and lakes. In the past, attention focused on the impacts of "end-of-pipe" discharges to streams where, prior to regulation, industrial and domestic wastewater were piped directly to streams. When the effects of this philosophy attracted national attention because of the burning of the Cuyahoga River in Ohio, a massive national effort, supported by the Clean Water Act, was undertaken to clean up point source discharges. That effort has been largely successful. As the negative impacts of pipe discharges diminished, the often-overlooked impacts of the nonpoint sources of pollutants, such as urban stormwater runoff, became more apparent. These sources, in which stormwater picks up and transports industrial, commercial, residential and transportation pollutants to water bodies, can be significant and can cause violations of water quality standards.

A study in Menomonee, Wisconsin, concluded that less than 20 percent of urbanization of an area was sufficient to cause significant degradation of surrounding receiving streams. This degradation is from both pollutants and altered habitat conditions. According to a 1992 USEPA document, stormwater runoff from agriculture and from urban areas are the two leading causes of surface water quality impairment nationwide. The nature of this pollutant problem, however, is different from traditional end-of-pipe discharges. Outfalls can be a point of discharge, such as a storm sewer outlet, or diffuse, such as sheet flow. Pollutants carried by stormwater become both a point and nonpoint source. Rainfall knows no facility or political boundaries. Runoff usually commingles and runs to the same discharge point or water body.

It is important to be able to understand the varied and ubiquitous nature of stormwater flows in order to identify ways to solve the pollutant problems that result from stormwater runoff. The concentration of pollutants in any one runoff event will vary from outfall to outfall, and these differences can be based on many factors. Concentrations will vary during the course of a storm, from event to event at the same point of discharge, from site to site within the same area, and from one urban area to a different urban area. Stormwater can follow various paths. It can be absorbed by surface soils; intercepted by vegetation; directly impounded by surface features such as a small depression, a lake or reservoir; infiltrate to groundwater, run directly to a lake or stream, or travel back and forth among these paths. For example, stormwater can infiltrate into groundwater and later exit to surface waters via a seep or spring. Finally, the amount of runoff contributed from a specific drainage area will vary by the soil moisture content prior to the storm, porosity of soil, relief of topography, organic material content of the soil, land cover, and size and duration of the storm event. In other words, stormwater runoff is not a continuous discharge with a predictable level of pollutants and a predictable daily volume as with the more commonly regulated and understood end-of-pipe discharges.

Urban Stormwater Regulations

Urban stormwater is regulated under the National Pollutant Discharge Elimination Permit System (NPDES) in several ways, as described in 40 CFR Part 122. Since Missouri has been

designated by the U.S. EPA to administer this program, this discussion will hereafter refer to state regulations to govern wastewater and stormwater discharges. Missouri environmental regulations require that discharges from large and medium municipal separate storm sewer systems (commonly referred to as an MS4) be permitted by the Department of Natural Resources, 10 CSR 20-6.200 (4). A large MS4 is defined as an incorporated place with a population of 250,000 or more. A medium MS4 is defined as an incorporated place with a population of 100,000 or more but less than 250,000, 10 CSR 20-6.200 (1)(C) 10 & 14. Counties are included in these definitions. However, if cities or counties have populations on combined sewer, local authorities can petition the department to exempt those populations in areas where the stormwater would flow to a combined sewer 10 CSR 20-6.200 (4)(B) 9.

Under these definitions, stormwater runoff is regulated in the Missouri cities of Springfield, Kansas City, and Independence. The City of St. Louis is almost entirely on combined sewers, so it has petitioned out of the current stormwater regulations and does not require a permit. Stormwater issues for these areas will be addressed under new Combined Sewer Overflow regulations. In addition, some portions of Kansas City are also on combined sewer, and the city was able to exempt these populations and petition into the category for medium-sized cities. Therefore, in Missouri, these three localities are classified as medium-sized cities and are required to have a stormwater discharge permit.

If urban runoff from other cities than these three is found to be a significant contributor of pollutants for reasons identified in 10 CSR 20-6.200(1)(C)10, then the department director may also designate these urban areas subject to regulation and require these urban areas to obtain a stormwater discharge permit for control of pollutants.

Please see the attached technical bulletin for additional information on Stormwater.
<http://www.dnr.mo.gov/oac/pub223.pdf>

Other stormwater regulations are applicable in urban areas, and are separate from and overlap some of the regulatory jurisdiction identified above. First, almost all industrial sources of stormwater runoff are regulated, 10 CSR 20-6.200(2). In Missouri, these sources are divided into three categories:

1. Industries that are required to have a stormwater discharge permit,
2. Transportation industries that are required to have a permit if any transportation-related activities such as fueling are exposed to stormwater, and
3. So-called “light” industries that are required to have a permit only if industrial activities are exposed to stormwater.

Since many of these industries are located in urban areas and their stormwater becomes part of the urban flow discharged by the MS4, the industrial stormwater regulations also offer a handle in managing urban stormwater pollutants.

Second, land disturbance activities greater than one acre as part of a common plan or sale over the life of the project are also required to obtain stormwater discharge permits, 10 CSR 20-

6.200(3). As with industrial sources, this permitting requirement offers a regulatory handle on construction activities that often occur largely in urban areas.

Pollutants and Sources in the Urban Landscape

Table 9 identifies common sources of urban runoff pollutants. As is apparent, the urban environment contributes almost the full spectrum of potential pollutants from a variety of sources. It is useful to remember that exposure to stormwater is the single unifying factor in these sources, pollutants, and potential pathways. The type of surface also plays a role. Roofing materials and galvanized pipes, for example, contribute trace metals to runoff. Other sources, such as pet droppings, motor oil, and road salt may accumulate on impervious surfaces such as roads and parking lots.

Table 12 - Pollutants and Sources in the Urban Landscape

Source	Pollutant of Concern
Erosion	Sediment and attached soil nutrients, organic matter, and other adsorbed pollutants.
Atmospheric Deposition	Hydrocarbons emitted from automobiles, dust, aromatic hydrocarbons, metals, and other chemicals released from industrial and commercial activities.
Construction Materials	Metals from flashing and shingles, gutters and downspouts, galvanized pipes and metal plating, paint and wood preservatives.
Manufactured Products	Heavy metals; halogenated aliphatics; phthalate esters; PAHs; other volatiles; phenols and oil from automobile use, zinc and cadmium from tire wear, and pesticides and phenols from other uses including industrial.
Landscape Maintenance	Fertilizer and pesticides. Generally as impervious area increases, nutrients build up on surfaces and runoff transport capacities also rise, resulting in high loads. Exceptions include intensively landscaped areas (e.g., golf courses and cemeteries).
Plants and Animals	Plant debris and animal excrement.
Septic Tanks	Coliform bacteria, nitrogen (NO ₃).
Non-Stormwater Connections	Inadvertent or deliberate discharges of sanitary sewage and industrial wastewater to storm drainage systems, including illicit connections, leaking sanitary collection systems, spills, industrial and commercial activities, construction activities, infiltration of contaminated groundwater, and improper disposal.
Accidental Spills	Pollutants of concern depend on the nature of the spill.

Source: USEPA. June 1992

Sediments

Sediment loading to streams in the urban environment comes largely from construction sites. Uncontrolled sediment loads from construction sites have been reported to be on the order of 35 to 45 tons per acre per year. Another study on the Anacostia River in Washington, D.C., estimated that sediment loads from construction sites range from 7 to 100 tons per acre per year. Sediment transport to streams carries with it nutrients (in particular, phosphorus) and organic matter that are attached to the soil. Physical modifications in the watershed and to stream channels can increase stream bank erosion, which can also contribute significant loads to receiving waters.

Environmental effects of increased suspended solids or settleable solids in streams include increased turbidity, reduced light penetration, reduced prey capture for sight feeding predators, clogging of gills/filters of fish and aquatic invertebrates, reduced benthic habitat, and reduced spawning and juvenile fish survival.

Nutrients

Nitrogen and phosphorus are the primary nutrients added to lakes and streams from stormwater runoff. Usually, phosphorus is the limiting nutrient in freshwater systems. Urban lakes and impoundments with detention times of about two weeks are at the greatest risk of environmental problems from nutrient enrichment. The addition of nutrients leads to algal growth and surface scums, water discoloration, and taste and odor problems. Furthermore, algal decomposition can lead to depressed dissolved oxygen levels and the release of toxins that may have been taken up or produced by the algae.

Generally, nutrients build-up and runoff increases as impervious surface areas increase. However, golf courses, cemeteries, and intensely landscaped areas may be exceptions to this rule if proper environmental management practices and controls are not used.

A study done on the Dillon Reservoir, which is a 2,970-acre impoundment of the Blue River in Colorado, provided information on phosphorus loading. Phosphorus was found to be the primary contributor to the eutrophication of the reservoir. Human activities in an urban area were found to account for about half of the total phosphorus load.

Another source of phosphorus in the urban environment is construction. Because phosphorus adsorbs to the soil, erosion and sediment deposition from construction activities can produce far higher loadings than any finished land use. These loadings are temporary, and levels will become more representative when the disturbed areas are stabilized.

Oxygen demanding substances

Urban runoff can depress dissolved oxygen (DO) levels after large storms, and biochemical oxygen demanding (BOD) solids can accumulate in bottom sediment causing impacts during periods of dry weather. BOD levels can exceed 20 mg/l during storm events, which can lead to anoxic conditions in shallow, slow-moving or poorly flushed receiving waters. The greatest BOD export typically occurs from older, highly impervious, highly populated urban areas with outdated combined storm sewers. Newer, low-density suburban residential development usually exports only moderate BOD levels.

Pathogens

Pathogens in urban stormwater runoff include bacteria, protozoa, and viruses that can cause disease in humans. In water quality analysis, the presence of bacteria such as fecal coliforms is generally used as an indicator of a potential risk to human health.

Older and more intensively developed urban areas produce the greatest export of bacteria. Animal excrement, combined sewers, sanitary sewer overflows or leaks, and illicit connections are primary sources of the contamination. A 1987 study by the City of New York found that coliform levels increased three to eight times above normal after rainfall events in several water

bodies and the study concluded that these increases were due to urban stormwater runoff and combined sewer overflows. Coastal areas have been forced to close acres of shellfish beds because of bacterial contamination. Since bacteria multiply faster in warm weather, there is also a seasonal effect.

The USEPA's Nationwide Urban Runoff Program (NURP) study, published in 1983, found that urban runoff typically contains fecal coliform densities of 10,000 to 100,000 organisms per 100 milliliters. Although these are obviously high numbers, drawing a conclusion on health effects is a little uncertain because coliforms are only an indicator of risk and because of the temporary nature of the discharge. However, these numbers can cause concern in slow-moving waterways and lakes and streams used by humans for primary and secondary contact recreation.

Toxic Pollutants

Toxic substances are broadly defined as materials capable of producing an adverse response or effect in a biological system. Toxic compounds such as trace metals, hydrocarbons and pesticides including herbicides are routinely detected in urban stormwater. Although presence in the water column is temporary in nature and human health and aquatic life impacts difficult to determine, the problem is that over the long-term, toxic chemicals tend to accumulate in benthic sediments of urban streams and lakes. Re-suspension of bottom sediments can present an additional exposure route to aquatic organisms.

Metals

Heavy metals are known to have toxic effects on aquatic life and the potential to contaminate drinking water supplies. Studies have found that the urban environment contributes copper, lead, and zinc in the highest concentrations, with cadmium a distant fourth. However, when inappropriate connections between sanitary and storm sewers are present, other heavy metals such as arsenic, beryllium, chromium, mercury, nickel, selenium, and thallium can be found. In the NURP study, lead, zinc, and copper were detected in over 70 percent of the samples taken of stormwater runoff. Chromium and arsenic were found in about 50 percent of the samples.

A study was conducted on the Saddle River, in New Jersey, of which 60 percent of the watershed is urbanized. Water samples were analyzed for lead, zinc, copper, nickel, and chromium. Lead and zinc accounted for 89 percent of the total metals observed. Copper, nickel and chromium were usually found in smaller quantities. When the actual rainfall was sampled, it was found that the rainwater contributed between 4 and 10 percent of the metals concentrations. In this study, metal loadings tended to correlate with increased percentages of commercial and industrial land-use.

The City of Bellevue, Washington, the U.S. Geological Survey, and the Municipality of Metropolitan Seattle monitored concentrations of metals in stormwater runoff in urban areas. This study found that heavy metals originated primarily from street dirt and that concentrations were higher near the source areas than in the stream itself. An interesting conclusion of this study shows the complex and interrelated nature of stormwater pollution with many other phenomena. Urbanization has led to rapid stormwater conveyance to streams which produces much larger stream discharges and shorter stream flow periods. This rapid transport actually lowers the pollutant concentrations in the stream as they are diluted and carried away more

rapidly. However, the increased flows also wash away smaller fish and organisms that, when present, are part of a healthy aquatic system. Therefore, reducing flows and maintaining natural flow patterns may also need to be accompanied by increased management practices upstream to prevent and treat contaminants from entering the waterway.

The City of Seattle found that copper concentrations in the Duwamish River exceeded the USEPA's acute freshwater criterion (18 µg/l) and the lead concentrations exceeded the USEPA chronic freshwater criterion (3.2 µg/l). The highest concentrations of metals were found unevenly distributed in the sediments of the river, suggesting that contaminants came from localized sources. In fact, lead concentrations were as high as 18,000 ppm in storm drains. Near a lead smelter, the sediments were found to contain 350,000 ppm lead. Again, sources were varied; illegal dumping, mismanagement of industrial chemicals and wastes, industrial activities, and storm drain sediments all contributed to the problem. Removal of sediments (some of which were treated as hazardous wastes) from storm drain systems and reductions in contaminant inputs from industrial facilities reduced loadings.

As noted earlier, trace metals can also be contributed when stormwater comes in contact with roofing materials, down spouts, galvanized pipes, metal plating, paints, wood preservatives, catalytic converters, brake linings, and tires. Finally, it should be noted that levels of lead in stormwater runoff in urban environments have declined over time with the use of non-leaded gasoline. However, levels of methyl-tetra-butyl-ether (MTBE) or other compounds added for octane enhancement are increasing.

Petroleum hydrocarbons

The rainbow colored sheen often found on urban surface waters comes from petroleum hydrocarbons. Sources include gasoline leakage from automobiles, spills, construction equipment, and service stations. Some hydrocarbons, such as the polynuclear aromatic hydrocarbons, are known to be toxic to aquatic life at low concentrations.

Hydrocarbons have a high affinity for sediment, and they tend to accumulate rapidly in the bottom sediments of lakes and estuaries. Bioaccumulation of hydrocarbons in fish and shellfish can be toxic to these aquatic organisms as well as becoming an exposure route to humans.

Pesticides

Pesticide use in urban areas is an emerging problem that has been overshadowed in the past by concerns about agricultural use. However, the growth of the lawn-care industry, expansion of urban areas, and new chemicals introduced into the market for home and garden use have affected the use of pesticides in urban areas and public perception of their environmental impacts. A 1991 USEPA study found that one-fourth of the conventional pesticides used in the United States were used for non-agricultural purposes. Of this amount, 69 million pounds of active ingredients were specifically used in homes and gardens. The large number and types of chemical compounds, the multitude of applicators, a long growing season, and the smaller amount of land area involved versus agricultural acreage make urban pesticide use a unique problem.

Urban drainage areas composed of vegetated areas contribute far less pesticide amounts to surface waters than urban drainage areas composed of impervious surfaces such as parking lots, making surface characteristics of the watershed an important part of the analysis of this problem.

Lawn and garden pesticides such as diazinon and 2,4-D were found in urban waters in a study completed in Minnesota. Some agricultural pesticides have been found to show up in urban watersheds, probably from atmospheric deposition. However, it is not known if atmospheric deposition of pesticides is a significant problem.

Sodium and chloride

Road salting in winter results in discharges of sodium and chloride to surface waters. These discharges can effect the taste of drinking water, and can damage salt-intolerant plant species. Sodium and chloride concentrations in runoff are not typically large enough to cause serious water resource problems because of the continuous flushing of storm events. However, they may become a problem in drinking water supplies and water resources such as lakes and groundwater that are not well flushed.

Temperature

In summer, runoff from urban areas can warm receiving waters. In a 1991 study of the thermal impacts of urban runoff, the study concluded that average stream temperature increased linearly with impervious area percentage. With 12 percent impervious area, some violations of temperature criteria occurred; violations increased in severity and frequency with increased imperviousness.

In addition, many of the treatment practices used to treat stormwater runoff contribute to a rise in temperature in receiving streams. Water held in impoundments becomes heated when held for an extended time in hot weather, causing receiving waters to have violations under both baseflow and storm runoff conditions. These rises in temperature can adversely affect algal species composition and cold-water invertebrates and fish.

Floatables

Storm water also carries with it solid waste left by humans on industrial and commercial facilities, parking lots, roads, and other impervious areas. Plastic and paper products, garden refuse, tires, and metal and glass containers make their way to waterways via stormwater. Such trash is mostly a visual problem, blemishing the esthetic quality of communities. However, some mortality of fish and other aquatic life occurs due to ingestion or entanglement.

Additional Factors

Besides the materials themselves, it is important to remember that other water quality characteristics such as temperature, pH, dissolved oxygen levels, alkalinity, hardness, and conductivity affect the behavior and fate of pollutants in the receiving stream. For example, metals generally become more soluble as pH drops below neutral. When this happens, the metals become more bioavailable to organisms and can cause greater adverse reactions. Depleted dissolved oxygen can also make some metals more soluble. Anaerobic conditions in the bottom of lakes release phosphorus from sediments. Elements creating hardness may mitigate some of the toxicity of many heavy metals.

Data have been collected that describe typical stormwater runoff characteristics. Table 10 below presents concentrations of several of the pollutants and compares those with water quality criteria to protect aquatic life. While concentrations generally range widely, the mean values tend to be low. Also, urban runoff often does not cause prolonged water quality criteria exceedances because of its temporal nature and dilution in the receiving water.

Table 13: Pollutant Concentration Statistics for General Urban and Highway Runoff

CONSTITUENTS	GENERAL	URBAN	HIGHWAYS RUNOFF		LIMITS FOR PROTECTION OF AQUATIC LIFE**
	MEAN	RANGE*	MEAN	RANGE*	
Suspended Solids (mg/L)	150 ²	2-2,890	220 ³	14-522	
BOD (mg/L)	9 ¹	0.41-159			X
COD (mg/L)	65 ¹	<10-1,031	124 ³	34-1,291	X
Lead (µg/L)	140 ¹	3-28,000	550 ³	10-3,775	16
Copper (µg/L)	34 ¹	4-560	43 ⁷	13-288	28
Zinc (µg/L)	160 ¹	10-5,750	380 ³	40-25,500	340
Cadmium (µg/L)	0.7 ⁸	0.7-30			11.8
Chromium (µg/L)	7 ⁸	<10-110			42
Nickel (µg/L)	12 ⁸	<2-126			500
Arsenic (µg/L)	13 ⁸	10-130			20
Organic Pesticides (µg/L)	X	0.002-0.35 ⁸			X
Phthalate Esters (µg/L)	X	0.06-160 ⁸			DEHP-5.9 all other PAEs- 12,000-2,900,000
Phenols (µg/L)	X	8-115 ⁸			100
Oil & Grease (mg/L)	7.8 ⁴	up to 35.7	30 ⁶		10
Total Hydrocarbons (mg/L)	3.7 ⁵	1.8-43			X
Polynuclear Aromatic Hydrocarbons (µg/L)	X	<0.01-12	3.7 ⁶		0.49-BaP 0.49-110,000-Others
Total Nitrogen (mg/L-N)	1.5 ¹	0.34-20	2.72 ³	up to 3.4	X
Total Phosphorus (mg/L)	0.33 ¹	0.01-4.3	0.59 ³	up to 0.7	
Alkalinity (mg/L)	38.2 ⁴	5.5-87			
PH	X	6.2-8.74		6.6-8.0 ⁶	6.5-9.0

X No data reported

* Range of actual values reported in literature from various studies unless otherwise indicated.

- ** Maximum concentrations for the protection of freshwater aquatic life or human health--fish consumption, Water Quality Standards, 10 CSR 20-7.031. <http://www.sos.mo.gov/adrules/csr/current/10csr/10c20-7b.pdf>
- *** For lakes with salmonids as predominant fish species.
- 1 U.S. Nationwide Urban Runoff Program database.
- 2 U.S. EPA database.
- 3 Median of U.S. Federal Highways Administration database.
- 4 Light Industrial Catchment in British Columbia.
- 5 General Urban Catchment in Philadelphia.
- 6 Highway runoff in England.
- 7 Highway runoff in Washington State.
- 8 Data from Metro Seattle.

Source: British Columbia Res. Corp. 1992 and Terrene Institute

Table 11 presents typical loadings for a number of pollutants and land uses. These numbers are expressed in the number of pounds contributed per acre per year. Variation from place to place and from year to year can be substantial. However, the numbers are useful in both quantifying the total loadings and understanding the nature of the problem.

Table 14: Typical Pollutant Loadings from Urban Land Uses in lbs/acre-y

LAND USE	TSS	TP	TKN	NH ₃ -N	NO ₂ -N	BOD	COD	Pb	Zn	Cu
Commercial	1,000	1.5	6.7	1.9	3.1	62	420	2.7	2.1	0.4
Parking lot	400	0.7	5.1	2.0	2.9	47	270	0.8	0.8	0.04
High-density residential	420	1.0	4.2	0.8	2.0	27	170	0.8	0.7	0.03
Medium-density residential	190	0.5	2.5	0.5	1.4	13	72	0.2	0.2	0.14
Low-density residential	10	0.04	0.03	0.02	0.1	NA	NA	0.01	0.04	0.01
Freeway	880	0.9	7.9	1.5	4.2	NA	NA	4.5	2.1	0.37
Industrial	860	1.3	3.8	0.2	1.3	NA	NA	2.4	7.3	0.50
Park	3	0.03	1.5	NA	0.3	NA	2	0.005	NA	NA
Construction	60,000	80	NA	NA	NA	NA	NA	NA	NA	NA

NA not available

Source: Pitt, 1991; Horner and Mar, 1982 and Terrene Institute

As noted above, water quality is impaired by land uses that contribute pollutants to groundwater or runoff. The quantity of water released is yet another issue and is influenced by the physical characteristics of the watershed, such as slope, vegetative cover, soil compaction, and impervious cover. All of these characteristics are extremely altered in an urban environment and lead to additional environmental degradation in urban streams. These changes are discussed in greater detail in the following section and at the Center for Watershed Protection website:

<http://www.cwp.org>

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Construction/Urban Best Management Practices

NONPOINT SOURCE WATER QUALITY CONSERVATION PRACTICE EFFECTS RANKING*

<u>Significant Positive</u> Water Quality Benefit or Control	+2
<u>Good</u> Water Quality Benefit or Control	+1
<u>Negligible Water</u> Quality Benefit or Control	0
<u>Negative</u> Water Quality Impact	-1
<u>Significant Negative</u> Water Quality Impact	-2
<u>Variable (Positive or Negative)</u> Water Quality Impact	+/-

Conservation Practice Not Applicable to Water Quality NA

* The numeric ranking is intended to be only a general guideline. Positive and negative impacts will vary from site to site. The conservation practices listed are examples and may change for each specific location. Specific conservation practices may be used for more than one resource concern.

Soil Tilth, Crusting, Water Infiltration, Organic Materials

Soil condition based on suitable combinations of mineral, water, air, organic matter, resulting in proper habitat for microbial activity and chemical reactions to occur.

Soil Compaction

Excess compression of soil particles and aggregates by machine, livestock, and natural consolidation, thereby affecting plant-soil-moisture-air relationships.

Soil Contaminants

Other Excess Animal Manures and Organics

Excess animal waste and other organics restrict the desired soil use.

Excess Fertilizers

Quantity of nutrients restricts desired soil use.

Damage On-site

Need to rework ground due to sediment thickness and distribution; crops destroyed; infertile deposition, especially for coarse textured soils.

Damage Off-site

Same as on-site damage. Off-site practice effects are less than on-site because of increased distance from source of problem.

Suspended Sediment and Turbidity

Suspended sediment is sediment held in surrounding fluid; turbidity is reduced clarity of fluids due to the presence of matter.

Aquatic Habitat Suitability

Water quality and physical nature of the stream provide a suitable home for fish and other aquatic life.

TABLE 15: NONPOINT SOURCE WATER QUALITY IMPACTS FROM STORMWATER MANAGEMENT PRACTICES APPLIED TO URBAN LAND DISTURBANCES (12/28/98)

CONSERVATION PRACTICE / (NRCS CODE)	SHEET & RILL EROSION	RILL & GULLY EROSION	STREAM- BANK EROSION	STREAM CHANNEL EROSION	REDUCED TOXICS & SALT	FLOODING	INCREASED PEAK FLOW	NUTRIENT POLLUTION	PESTICIDE POLLUTION	SEDIMENT DAMAGE	DUST CONTROL	CONSTRUCTION ROAD MAINTENANCE	WATER TABLE CONTROL	ORGANIC POLLUTION
BUFFER ZONE/STRIP (000)	+1	+1	+2	+2	+1	+/-	+/-	+2	+/-	+1	NA	NA	NA	+2
CATCH BASIN CLEANING (000)	NA	NA	NA	NA	NA	NA	NA	+1	+1	NA	NA	+1	NA	+2
CHECK DAM, TEMPORARY (000)	0	+2	NA	NA	NA	NA	+1	+1	+/-	+2	NA	NA	NA	+1
CHEMICAL STABILIZATION (000)	+1	-1	NA	NA	0	NA	NA	+1	+/-	+2	+2	NA	NA	+/-
CONSTRUCTION ENTRANCE/EXIT PAD, TEMPORARY GRAVEL (930)	+/-	+/-	NA	NA	NA	NA	NA	NA	NA	+1	+1	+2	NA	NA
DE-ICING CHEMICAL USE/STORAGE (000)	NA	NA	NA	NA	+2	NA	NA	+/-	+/-	NA	NA	NA	NA	+1
DETENTION PONDS AND BASINS (000)	+/-	+2	+1	+1	+1	+2	+2	+1	+/-	+2	NA	NA	NA	+1
DETENTION PONDS AND BASINS, EXTENDED (000)	+/-	+2	+1	+1	+1	+2	+2	+1	+1	+2	NA	NA	NA	+1
DIKES/SWALES, INTERCEPTOR (000)	+2	+1	+1	0	+1	+/-	+1	+1	+1	+2	NA	+/-	NA	+/-
DIVERSION DIKE (820)	+2	+2	+1	0	+1	+1	+1	+1	+1	+1	NA	+1	NA	+/-
DIVERSION, PERMANENT (815)	+2	+2	+1	+/-	+1	+1	+1	+1	+1	+1	NA	+1	NA	+/-
DIVERSION, TEMPORARY (955)	+2	+2	+1	+/-	+1	+1	+1	+1	+1	+1	NA	+1	NA	+/-
DUST CONTROL (825)	NA	NA	NA	NA	+1	NA	NA	+/-	+/-	0	+2	+1	NA	+1

CONSERVATION PRACTICE / (NRCS CODE)	SHEET & RILL EROSION	RILL & GULLY EROSION	STREAM- BANK EROSION	STREAM CHANNEL EROSION	REDUCED TOXICS & SALT	FLOODING	INCREASED PEAK FLOW	NUTRIENT POLLUTION	PESTICIDE POLLUTION	SEDIMENT DAMAGE	DUST CONTROL	CONSTRUCTION ROAD MAINTENANCE	WATER TABLE CONTROL	ORGANIC POLLUTION
ENERGY DISSIPATERS (000)	+/-	+2	+2	+2	NA	NA	+1	+/-	+/-	+2	NA	+1	NA	+1
EROSION BLANKET (830)	+2	+/-	+1	+1	+/-	NA	NA	+1	+/-	+2	+1	NA	NA	+2
FILTER STRIP, URBAN (835)	+2	+/-	+2	NA	+1	NA	NA	+1	+/-	+2	+1	NA	NA	+2
FLOATABLE SKIMMERS (000)	NA	NA	NA	NA	NA	NA	NA	0	0	+1	NA	NA	NA	+1
GEOTEXTILES (000)	+2	+/-	+/-	NA	+1	NA	NA	0	0	+2	NA	+/-	NA	+1
GRADE STABILIZATION STRUCTURE (000)	+/-	+2	+1	+/-	0	0	+1	0	0	+2	NA	+/-	NA	0
GRADIENT TERRACE (000)	+2	+1	+1	NA	0	0	NA	+1	+1	+2	NA	+/-	NA	+/-
GRASSED-LINED CHANNELS (840)	+1	+2	+1	+2	0	+1	NA	+1	+/-	+2	NA	+/-	NA	+/-
GRAVEL/STONE FILTER BERM (000)	+2	+2	+2	NA	+/-	NA	NA	+/-	0	+2	NA	+/-	NA	+2
IMPOUNDMENT STRUCTURE - FULL FLOW (841)	+2	+2	+1	+2	NA	+2	+2	+/-	+/-	+2	NA	NA	+2	0
IMPOUNDMENT STRUCTURE- ROUTED (842)	+2	+2	+2	+2	+1	+2	+2	+/-	+/-	+2	NA	NA	+2	0
INFILTRATION BASIN (845)	+1	+1	0	0	+1	+1	+2	+/-	+/-	+2	NA	NA	+/-	+2
INFILTRATION TRENCH (845)	+1	+1	0	0	+1	+1	+2	+/-	+/-	+2	NA	NA	+/-	+2
INLET PROTECTION - BLOCK AND GRAVEL (850)	+1	0	0	0	NA	NA	NA	+1	+1	+1	NA	+/-	NA	+1
INLET PROTECTION - EXCAVATED DRAIN (855)	+1	0	0	0	NA	NA	NA	+1	+1	+1	NA	+/-	NA	+1
INLET PROTECTION -FABRIC	+1	0	0	0	NA	NA	NA	+1	+1	+1	NA	+/-	NA	+1

CONSERVATION PRACTICE / (NRCS CODE)	SHEET & RILL EROSION	RILL & GULLY EROSION	STREAM- BANK EROSION	STREAM CHANNEL EROSION	REDUCED TOXICS & SALT	FLOODING	INCREASED PEAK FLOW	NUTRIENT POLLUTION	PESTICIDE POLLUTION	SEDIMENT DAMAGE	DUST CONTROL	CONSTRUCTION ROAD MAINTENANCE	WATER TABLE CONTROL	ORGANIC POLLUTION
DROP (860)														
LAND GRADING (865)	+2	+2	+1	NA	+/-	+1	0	+/-	+/-	+1	NA	+2	NA	+/-
LEVEL SPREADER (870)	+1	+1	+1	NA	+/-	0	+/-	+/-	+/-	+1	NA	0	NA	+/-
LOT BENCHING (000)	+2	+/-	+1	NA	+/-	0	+/-	+/-	+/-	+1	NA	NA	NA	+1
MULCHING (875)	+2	+2	+1	NA	+1	NA	+1	+2	+/-	+2	+2	NA	NA	+1
OIL/GRIT SEPARATORS (000)	NA	NA	NA	NA	NA	NA	NA	NA	+/-	+1	NA	0	NA	+/-
POROUS PAVEMENT (890)	+1	+1	+/-	NA	+1	+1	+1	+/-	+/-	+1	NA	+1	+1	+/-
PORTABLE SEDIMENT TRAP (895)	0	0	NA	NA	+/-	NA	NA	+1	+/-	+2	NA	+1	NA	+1
PRESERVATION OF NATURAL VEGETATION (000)	+2	+2	+2	+/-	+2	+1	+1	+2	+2	+2	NA	+2	NA	+2
RETAINING WALLS (000)	+2	+2	+2	NA	NA	NA	NA	+2	+2	+1	NA	+1	NA	+2
RIGHT-OF-WAY DIVERSION [WATER BARS] (900)	+2	+1	+1	NA	+/-	+1	NA	+2	+2	+1	NA	+2	NA	+2
RIPRAP-LINED CHANNEL (000)	+1	+2	+1	+2	NA	NA	+/-	0	NA	+2	NA	+/-	NA	NA
ROCK DAM (000)	+1	+2	+1	+1	NA	+1	+1	0	NA	+1	NA	+1	NA	+1
ROCK OUTLET PROTECTION (910)	0	+2	+2	+2	NA	+/-	0	NA	NA	+1	NA	+1	NA	NA
SEDIMENT BASIN, PERMANENT (000)	+1	+1	+1	+/-	+1	+1	+1	+1	+/-	+2	NA	+1	+/-	+2
SEDIMENT BASIN,														

CONSERVATION PRACTICE / (NRCS CODE)	SHEET & RILL EROSION	RILL & GULLY EROSION	STREAM- BANK EROSION	STREAM CHANNEL EROSION	REDUCED TOXICS & SALT	FLOODING	INCREASED PEAK FLOW	NUTRIENT POLLUTION	PESTICIDE POLLUTION	SEDIMENT DAMAGE	DUST CONTROL	CONSTRUCTION ROAD MAINTENANCE	WATER TABLE CONTROL	ORGANIC POLLUTION
TEMPORARY (960)	+1	+2	+/-	NA	+/-	0	+1	+/-	+1	+2	NA	+2	NA	+2
SEDIMENT TRAP, TEMPORARY (960)	+1	+2	+/-	NA	+/-	0	+1	+/-	+1	+2	NA	+2	NA	+2
SEEDING, PERMANENT (880)	+2	+2	+2	NA	+2	+2	+2	+2	+2	+2	+2	+2	NA	+2
SEEDING, TEMPORARY (965)	+2	+2	+2	NA	+2	+2	+2	+2	+2	+2	+2	+2	NA	+2
SILT CURTAIN, FLOTATION (000)	NA	NA	NA	NA	+1	NA	NA	+2	+/-	+2	NA	NA	NA	+2
SILT FENCE (920)	+2	+2	0	NA	+1	NA	+1	+1	0	+2	+/-	+2	NA	+2
SLOPE DRAIN, TEMPORARY (970)	0	+2	NA	NA	+1	+/-	+/-	+/-	+/-	+1	NA	+1	+2	+/-
SODDING (925)	+2	+2	+2	NA	+1	+2	+2	+2	+2	+2	+2	+1	NA	+2
SOIL BIOENGINEERING FOR SLOPE PROTECTION (000)	+2	+2	+2	NA	NA	NA	NA	+2	+2	+2	0	NA	NA	+1
STABILIZED CONSTRUCTION ENTRANCE/EXIT PAD (930)	+1	+/-	NA	NA	NA	NA	NA	NA	NA	+1	0	+2	NA	NA
STORMWATER WETLAND, URBAN (800)	+1	+1	+1	+2	+2	+2	+2	+2	+1	+2	NA	NA	+2	+2
STRAW BALE BARRIER (935)	+2	+2	NA	NA	NA	NA	NA	+1	+1	+2	0	+2	NA	+2
STREAM CROSSING, TEMPORARY (975)	NA	NA	+1	+1	NA	NA	-2	NA	NA	NA	+2	+/-	NA	NA
STREAMBANK STABILIZATION (940)	NA	+2	+2	+2	0	NA	+/-	+2	+2	+2	+/-	NA	NA	+2
STREAMBANK SETBACK (000)	+2	+2	+2	+2	0	+2	+2	+2	2+	+2-	+/-	NA	NA	+2

CONSERVATION PRACTICE / (NRCS CODE)	SHEET & RILL EROSION	RILL & GULLY EROSION	STREAM- BANK EROSION	STREAM CHANNEL EROSION	REDUCED TOXICS & SALT	FLOODING	INCREASED PEAK FLOW	NUTRIENT POLLUTION	PESTICIDE POLLUTION	SEDIMENT DAMAGE	DUST CONTROL	CONSTRUCTION ROAD MAINTENANCE	WATER TABLE CONTROL	ORGANIC POLLUTION
SUBSURFACE DRAIN (945)	+1	+1	+2	-2	+2	+1	+2	+/-	+/-	+1	NA	+2	+2	+2
SUMP PIT (950)	NA	NA	NA	NA	+2	NA	NA	+2	+2	+2	NA	NA	+2	+1
SURFACE ROUGHENING (000)	+2	+/-	+1	+1	+/-	NA	NA	+2	+1	+2	+1	NA	NA	+/-
SWALE, TEMPORARY (980)	+/-	+1	+/-	+1	+/-	+1	NA	+/-	+/-	+1	NA	+1	NA	+1
TOP SOILING (981)	+2	+1	+1	NA	+2	+1	+1	+1	+1	+1	+1	NA	NA	+2
TREE AND SHRUB PLANTING (985)	+2	+2	+2	+2	+2	+1	+2	+2	+2	+2	+2	NA	+2	+2
TREE AND SHRUB PROTECTION (990)	+2	+2	+2	+2	NA	+2	+1	+2	+2	+1	+2	NA	+1	+2
VEGETATIVE STREAMBANK STABILIZATION (995)	+2	+2	+2	+2	NA	NA	+1	+1	+1	+1	+2	NA	+1	+2
GOOD HOUSEKEEPING PRACTICES														
ACCIDENTAL SPILLS (000)	NA	NA	NA	NA	+2	NA	NA	+1	+1	NA	NA	NA	NA	+1
CONCRETE TRUCKS (000)	NA	NA	NA	NA	+2	NA	NA	NA	NA	NA	NA	NA	NA	+1
CONTAMINATED SOILS (000)	NA	NA	NA	NA	+2	NA	NA	NA	NA	NA	NA	NA	NA	NA
CONTROL OF ALLOWABLE NON-STORM WATER DISCHARGES (000)	+/-	+1	+1	+1	NA	+2	NA	NA	NA	+2	NA	NA	NA	+2

CONSERVATION PRACTICE / (NRCS CODE)	SHEET & RILL EROSION	RILL & GULLY EROSION	STREAM- BANK EROSION	STREAM CHANNEL EROSION	REDUCED TOXICS & SALT	FLOODING	INCREASED PEAK FLOW	NUTRIENT POLLUTION	PESTICIDE POLLUTION	SEDIMENT DAMAGE	DUST CONTROL	CONSTRUCTION ROAD MAINTENANCE	WATER TABLE CONTROL	ORGANIC POLLUTION
CONSTRUCTION WASTES (000)	NA	NA	NA	NA	+2	NA	NA	+1	NA	NA	NA	NA	NA	+2
DEWATERING (000)	NA	NA	NA	NA	+2	+2	NA	NA	NA	NA	NA	NA	+2	NA
FERTILIZERS/DETERGENTS (000)	NA	NA	NA	NA	+2	NA	NA	+2	NA	NA	NA	NA	NA	+2
HAZARDOUS WASTES (000)	NA	NA	NA	NA	+2	NA	NA	NA	NA	NA	NA	NA	NA	NA
LITTER CONTROL (000)	NA	NA	NA	NA	+2	NA	NA	NA	NA	NA	NA	NA	NA	NA
NATURAL GEOLOGIC DRAINAGE (000)	NA	NA	+1	+1	NA	+1	+1	NA	NA	NA	NA	NA	+2	NA
PESTICIDES (000)	NA	NA	NA	NA	+2	NA	NA	NA	+2	NA	NA	NA	+2	NA
PETROLEUM PRODUCTS (000)	NA	NA	NA	NA	+2	NA	NA	NA	NA	NA	NA	NA	NA	NA
SANDBLASTING GRITS (000)	NA	NA	NA	NA	+2	NA	NA	NA	NA	+1	+2	NA	NA	+2
SANITARY/SEPTIC DISPOSAL (000)	NA	NA	NA	NA	+2	NA	NA	+2	NA	NA	NA	NA	NA	+2
SUMP PIT (000)	NA	NA	NA	NA	NA	+1	NA	NA	NA	NA	NA	NA	NA	NA
WASTE DISPOSAL (000)	NA	NA	NA	NA	+2	NA	NA	NA	NA	NA	NA	NA	NA	NA
INSPECTIONS	+2	+2	+2	+1	+2	+1	+2	+2	+2	+2	+2	+2	+2	+2
MAINTENANCE	+2	+2	+2	+1	+2	+1	+2	+2	+2	+2	+2	+2	+2	+2
RECORDKEEPING	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2

URBAN CONSERVATION PRACTICES FOR WATER QUALITY (10/28/98)

Buffer Zone/Strip

Buffer zones are vegetated strips of land used for temporary or permanent water quality benefits. Buffer zones are used to decrease the velocity of storm water runoff, which in turn helps to prevent soil erosion. Buffer zones are different from vegetated filter strips because buffer zone effectiveness is not measured by its ability to improve infiltration (allow water to get into the ground). The buffer zone can be an area of vegetation that is left undisturbed during construction, or it can be newly planted. Establishing new buffer zones requires the establishment of good dense turf, trees, and shrubs. Buffer zones are particularly effective on floodplains, next to wetlands, streambanks, lakes, drinking water reservoirs, and on steep, unstable slopes. Buffer zones provide multiple benefits, improved wildlife habitat, increased water infiltration, better runoff water quality, improved recreation, increased aesthetic values, and reduced sediment from sheet, rill and gully erosion. Careful maintenance is important to ensure healthy vegetation. The need for routine maintenance such as mowing, fertilizing, liming, potential irrigation, pruning, and weed and pest control will depend on the species of plants and trees selected, soil types, and climatic conditions. Maintenance of plantings requires occasional debris removal and protection.

[Riparian Forest Buffer (391); Streambank and Shoreline Protection (580); Wildlife Upland Habitat Management (645); Wildlife Wetland Habitat Management (644)]

Catch Basin Cleaning

Catch basins are chambers or sumps installed in underground stormwater drains, usually at the curb, which allow surface water runoff to enter and trap coarse sediment and solid debris from passing through the drain into receiving waters. Clean-out of the basins (traps) is required periodically to be effective. The basins benefit water quality by reducing sediment loading, and trapping oxygen-demanding substances from reaching surface waters. Typical catch basins are designed to retain 0.5-1.5 cubic yards of materials. If not cleaned on a regular basis, surface water quality could actually become worse once the basin reaches 40-50% design capacity due to increased turbulence from the inflow through flushing of captured sediment and the materials that have decayed while trapped in the basin. Properly designed basins are known to trap 57% of coarse solids and 17% of the equivalent BOD. This practice is effective during and after land disturbance activities.

Check Dams (Temporary)

A check dam is a small, temporary or permanent dam constructed across a drainage ditch, swale, or channel to lower the speed of concentrated flows. Reduced runoff speed reduces erosion and gully formation in the channel thus allowing sediments to settle out. It is installed in steeply sloped swales or in swales where adequate vegetation cannot be established. Check dams may be built from logs, stone, or pea gravel-filled sandbags. This should be used only in small open channels which will not be overtopped once the

dam(s) are constructed. [*It should be noted that it is illegal in Missouri to use streams as a treatment device.*] The center section of the dam should be lower than its edges. Dams should be spaced so the toe of the upstream dam is the same elevation as the next downstream dam top. Frequent inspections and regular maintenance are critical to the operation of this measure. Remove sediment once 50% of the storage area behind the check dam is filled

Chemical Stabilization

Chemical stabilization practices, often referred to as a chemical mulch, soil binder, or soil palliative are temporary erosion control practices. Emulsion materials made of vinyl, anionic asphalt, latex, resin in water, acrylic, non-acrylic or rubber sprayed onto the surface of the soil to hold the soil in place and protect against erosion from stormwater runoff and wind. Many of the products used for chemical stabilization are human-made, and many different products are on the market. Chemical stabilization can be used as an alternative where temporary seeding practices cannot be used because of soil or climate. It can provide immediate, effective, and inexpensive erosion control anywhere erosion is occurring on a site. Follow the manufacturer recommended application rates for chemical stabilization products and to prevent the products from forming ponds and creating large areas where moisture cannot penetrate into the soil below.

[*Mulching (484); Critical Area Seeding (342)*]

Construction Entrance/exit Pad, Temporary Gravel (930)*

A stone base designed to provide a buffer area where construction vehicles can drop their mud to avoid transporting it onto roads. This practice applies anywhere traffic will be leaving a construction site and moving directly onto a public road or other paved area. This may be used in combination with other practice measures to accomplish the specific site or area needs. This should not be used as an equipment washing site unless special provisions have been made for the collection of wash-water before reaching the public road or other paved area. A permit may be required if such wash water is not properly collected and treated by a public water treatment system facility.

[*Access Road (560)*]

De-icing Chemical Use and Storage

Tremendous amounts of de-icing chemicals are used each winter on roads, sidewalks, and parking lots (such as sodium chloride or salt). Proper use and storage of de-icing agents will reduce the chance of high chloride concentrations in runoff water that may reach surface water and damaging the environment. Although salt is the main pollutant addressed in this standard, trace metals have also been found to be associated with the use of agents for de-icing. It has been estimated that 80% of the environmental damage from de-icing chemicals is caused from inadequate storage facilities. Prevention of over application of de-icing chemicals will reduce quantities of chloride from entering stormwater runoff as a pollutant. Stockpiles should be completely contained under a roof or cover with a water repellant cover. Calibrating equipment is another means of reducing over application. Apply only to areas where eminent danger exists to safe traffic passage (curves, inclines, or heavy traffic intersections). Low use roadways should have minimal use of de-icing chemicals.

Detention Ponds and Basins*

Detention ponds and basins are designed to hold stormwater runoff and release the water slowly to prevent downstream flooding and stream erosion. Detention ponds and basins are an extremely effective water quality control measure and significantly reduce the frequency of erosive floods downstream. Ideally, a detention pond will store at least the first 2 inch of runoff from the design storm and release the remainder at or below the pre-development rate. The design includes a permanent pool of water (retention). Their usage is suited to larger drainage areas of 20-50 acres in more intensively developed areas. Regular detention ponds have less storage and different conduits than extended detention ponds. Both can have a permanent pool of water or a dry basin and can have sediment storage held as part of the design. This practice has a storm runoff detention time of 24-48 hours and a life-span of 10-20 years. This practice is enhanced with other complementary measures. Clean out should be regularly scheduled. Personal safety such as fencing should be installed to protect small children in urban settings. Structures must meet all local, state and federal dam safety requirements.

[*Grade Stabilization Structure (410)*; *Structure for Water Control (578)*; *Ponds (378)*; *Sediment Basin (350)*]

Detention Ponds and Basins, Extended*

A dam designed to hold stormwater runoff for a prolonged time and release the water slowly to prevent downstream flooding, stream erosion, and pollution. Extended detention ponds and basins improve the quality of runoff by retaining potential chemical-laden sediment. They also significantly reduces the peak flow rate from flood events, thus reducing the frequency of erosive floods downstream. Ideally, an extended detention pond will store the first one inch of runoff and release the remainder at or below the pre-development rate. This is best suited to large, intensively developed sites with a drainage area of 20-100 acres. Extended detention ponds differ from regular detention ponds by increasing the storage volume. Both can have permanent pools of water (retention basin) or dry basins and can be designed to hold sediment. The detention time is designed for 24-72 hours and a life-span of 10-20 years. A designed length to width ratio of 3:1 or greater maximizes the trapping efficiency. This practice is enhanced by using complementary measures to improve water quality effectiveness. Clean out should be regularly scheduled. Personal safety such as fencing should be installed to protect small children in urban settings. Structures must meet all local, state and federal dam safety requirements.

[*Grade Stabilization Structures (410)*; *Structure for Water Control (578)*; *Ponds (378)*; *Sediment Basin (350)*]

Dikes & Swales, Interceptor

Interceptor dikes (ridges of compacted soil) and swales (excavated depressions) are used to keep upslope runoff from crossing areas where there is a risk of erosion. They reduce the amount and speed of flow and then guide it to a stabilized outfall (point of discharge) or sediment trapping area. Interceptor dikes and swales divert runoff using a combination of earth dike and vegetated swale. Runoff is channeled away from locations where there is a high risk of erosion by placing a diversion dike or swale at the top of a sloping

disturbed area. Dikes and swales also collect overland flow, changing it into concentrated flows. Interceptor dikes and swales can be either temporary or permanent storm water control structures. These are generally built around the perimeter of a construction site before any major soil disturbing activity takes place. They may be used to protect existing buildings, stockpiles, and other areas not fully stabilized. Temporary dikes or swales constructed on the downslope side of the disturbed or high-risk area will prevent runoff that contains sediment from leaving the site before sediment is removed. When constructed along the upslope perimeter of a disturbed or high-risk area, dikes and swales prevent runoff from the upslope area from entering the unprotected or critical area. For short slopes, a dike or swale at the top of the slope reduces the amount of runoff entering the disturbed area. For longer slopes several dikes and swales will be needed. In all cases the surface water runoff is guided to a sediment trapping basin and has a stabilized outlet.

[*Diversion (362)*]

Diversion Dike (820)

A diversion dike is a berm, dike or dike and channel constructed along the perimeter of a disturbed construction area. The purpose of this practice is to prevent storm runoff from entering the work area or to prevent sediment-laden runoff from entering the construction site without first passing through a sediment trapping device. The dike consists of compacted soil and stone, riprap, or vegetation to stabilize the channel. Dikes are used in construction areas to control sediment, erosion, or flood damage. Dikes can be used in site conditions such as 1) above disturbed existing slopes and above cut or fill slopes to prevent runoff over the slope; 2) across unprotected slopes, as slope breaks, to reduce slope length; 3) below slopes to divert excess runoff to stabilized outlets; 4) to divert sediment-laden water to sediment traps; 5) at or near the perimeter of the construction area to keep sediment from leaving the site; 6) above disturbed areas before stabilization to prevent erosion and maintain acceptable working conditions; and 7) temporary diversions that serve as a sediment trap when the site has been over-excavated on a long flat or in conjunction with a sediment/silt fence. Diversion dikes do not usually encircle the area. This is a special application of a temporary or permanent diversion, but it differs in its location, the grade is usually fixed, and the cross-section and stabilization requirements are based on the existing grade. Limit drainage areas to 5 acres or less; avoid erosive velocities in steep areas; and identify areas of excessive sediment buildup since this can cause unnecessary overtopping and potentially greater downstream damage.

[*Dike (Earthen) (356)*]

Diversion, Permanent (815)*

A permanent watercourse (channel, ridge, or a channel and supporting compacted ridge), constructed across the slope to collect and divert runoff. The purpose of this practice is to divert excess surface water from one area for use or safe disposal in other areas where it can be temporarily stored or released to a stable outlet. This permanent site development practice applies to areas where runoff can be diverted and used or disposed of safely to prevent localized flood damage, excessive wetness, erosion, to allow establishment of down slope vegetation, or reduce sediment damage. It should be

installed 1) above steep slopes to limit surface runoff onto the slope; 2) across long slopes to reduce slope length to prevent gully erosion; 3) below steep grades where flooding, seepage problems, or sediment depositions may occur; or 4) around buildings or areas that are subject to damage from runoff. Designs should be limited to drainage areas of 5 acres or less.

[*Diversion (362)*]

Diversion, Temporary (955)*

A temporary ridge or excavated channel or combination designed and installed across sloping land on a predetermined grade. The practice protects work areas from upslope runoff and diverts sediment-laden water to an appropriate sediment trapping facility or stabilized outlet. This applies to construction areas where runoff can be temporarily diverted to control erosion, sediment retention onsite, or flood damage. Specific locations or conditions include: 1) above disturbed existing slopes, and above cut or fill slopes to prevent runoff over the slope; 2) across unprotected slopes (slope breaks) to reduce slope length; 3) below slopes to divert excess runoff to stabilized outlets; 4) where needed to divert sediment-laden water to sediment traps; 5) at or near the perimeter of the construction area to keep sediment from leaving the site; 6) above disturbed areas before stabilization to prevent erosion and maintain acceptable working conditions; 7) a drainage area of 5 acres or less; 8) used for less than 18 months; and 9) where active construction activities make the use of a permanent practice unfeasible.

[*Diversion (362)*]

Dust Control (825)*

Controlling dust blowing and movement on construction sites includes a wide range of techniques that reduce movement of wind-borne soil particles and other potential pollutants from soil surfaces. The purpose of this practice is to prevent blowing and movement of dust from exposed soil surfaces, reduce on-site and off-site damage, minimize health hazards, improve traffic, and improve personal safety. This practice is applicable to areas subject to dust blowing and movement where damage is likely without treatment (e.g. construction routes). Dust control can be achieved using one or more of these methods; 1) mulches (including gravel mulch); 2) vegetative cover; 3) spray-on adhesives (chemical stabilization); 4) tillage; 5) irrigation, 6) wind barriers; 7) calcium chloride; 8) stone; 9) street cleaning; or 10) permanent vegetation. As the distance across bare soil increases wind erosion becomes more severe. Consequently, rainfall infiltration in this area becomes more difficult creating a moisture deficit which will inhibit vegetative establishment and increase surface water runoff and erosion. Mulching when used in this situation conserves moisture, prevents surface crusting, reduces runoff and erosion, and enhances the environment for seedling vegetative growth. This is very critical on sloping lands.

Energy Dissipaters*

This practice is designed to prevent erosion at the outlet of a channel or conduit by reducing the velocity of flow and dissipating the energy. Energy dissipaters usually consist of riprap-lined aprons, plunge pools, a reinforced concrete flume with concrete baffles, a reinforced concrete box with chambers or baffles or in combination with

riprap. This practice applies where high velocity discharge must be released on erodible material. Outlet protection may require the use of a plunge pool to dispel more energy with greater efficiency when used in combination with designed aprons. Energy dissipaters need to be designed by a professional consultant that is site specific, with zero grade aprons, plunge pools, and no outfall at the apron end.

Erosion Blanket (830)*

This practice refers to the application of a manufactured protective blanket of straw, jute, wood or other plant fibers, plastic, nylon, paper or cotton fibers formed into a mat, usually with a mesh on one or both sides of the mat. Many products today are pre-packaged with mulch, fertilizer, and seed in the mat for ease of placement. The purpose of this practice is to protect the soil surface from raindrop impacts and overland flow during the establishment period of grass or other vegetation. It also reduces soil moisture loss due to evaporation. The practice should be used for the protection of a newly seeded area with critical short steep slopes, where the hazard is high, and the plant growth is likely to be slow in providing adequate cover. This is especially important where flowing water may occur before the grass is established. Erosion control blankets are typically used as an alternative to mulching but can be used to provide structural erosion protection. The most common application is in the bottoms of small channels (velocities up to 12 cubic feet per second) and on steep embankments (slopes up to 1:1). This practice is used in combination with other practices such as permanent seeding. [Critical Area Seeding (342); Mulching (484)]

Filter Strip, Urban (835)

A filter strip is an area created of vegetation designed to remove sediment and other pollutants only from surface water runoff. The purpose is to remove sediment and other pollutants from runoff water by slowing the water down to allow filtration, deposition, infiltration, adsorption, reduced velocities, reduced overland flows, and vegetative uptake. This practice may be applied in a variety of uses where surface water runoff is discharged as overland sheet flow. [This does not apply to high velocity runoff or concentrated flows.] It is limited to a drainage area, 5 acres or less, with a minimum width of 50 feet plus an additional 4 feet for each 1% slope increase over a 5% slope up to a maximum of 15% slope. Filter strip widths differ for grassed versus wooded areas. This is used in combination with other measures. Some typical locations of vegetated filter strips include: 1) on construction sites and land undergoing development where filter strips are needed at the lower edge of disturbed areas to reduce damage from overland (sheet) flow to adjacent property; 2) above or adjacent to wetlands, streams, ponds, lakes, or conservation areas used to store, manage, or convey water, where shallow sheet-flow conditions can be maintained to reduce sediment and associated materials; and 3) adjacent to roadways, parking lots, and other impervious surfaces to disconnect them from streams and other water resources.

[Filter Strip (393)]

Floatable Skimmers

Floatable skimmers are devices used to retain floating debris and oil in detention areas. The floating debris and oil eventually sink to the bottom of the detention area and

become part of the sediment or are removed from the surface through regular maintenance. It is useable for trapping floating organic matter and oils which contain nutrients, oxygen-demanding substances and hydrocarbons. The effectiveness of any skimmer depends upon the amount and type of floating materials transported by the runoff. In areas with excessive leaves, oils, or trash, this practice can prove very beneficial to water quality. These devices are normally attached to vertical outlets, corrugated metal outlets, or baffled weir outlets. Maintenance is required after each stormwater runoff event to maintain flow efficiency.

Geotextiles

Geotextiles are porous fabrics known in the construction industry as filter fabrics, road rugs, synthetic fabrics, construction fabrics, or simply fabrics. Geotextiles are manufactured by weaving or bonding fibers made from synthetic materials such as polypropylene, polyester, polyethylene nylon, polyvinyl chloride, glass, and various mixtures of these. As a synthetic construction material, geotextiles are used for a variety of purposes. The uses of geotextiles include separators, reinforcement, filtration and drainage, and erosion control. Some geotextiles are also biodegradable materials such as mulch matting and netting. Mulch mattings are materials (jute or other wood fibers) that have been formed into sheets of mulch that are more stable than normal mulch. Netting is typically made from plastic, paper, cotton, jute, or other wood fiber that can be used to hold mulching and matting together on the ground surface. It also can be used alone to stabilize soils while the plants are growing; however, some do not retain moisture or temperature well. Mulch binders (either asphalt or synthetic) are sometimes used instead of netting to hold loose mulches together on the soil surface. Geotextiles can be used for erosion control alone (as a matting) to stabilize the soils at the bottom of channels or swales where surface water runoff concentrates; used to protect long slopes during vegetative establishment; and on streambanks where moving water is likely to wash out new planting. When used as a separator (under riprap, sand and gravel) the separation between the two mediums prevents soil or sand from migrating into the protective layer and from allowing soil erosion from under the protective layer. Effectiveness is dependent upon firm, continuous matting in direct contact with the soil surface and the materials used. The various types of geotextiles are numerous so the selected fabric must match the intended application.

[*Critical Area Seeding (342); Mulching (484)*]

Grade Stabilization Structure

A grade stabilization structure is a permanent structure or series of structures designed to drop surface water runoff to a lower elevation without erosion. Grade stabilization structures are commonly used when discharges from a stormwater conveyance channel (grassed waterway) or diversion must be dropped to a lower elevation receiving channel. These structures can also be used within channels to flatten the channel grade thereby reducing velocities. Grade stabilization structures can prevent gully erosion caused by overfalls or unstable soil in channels. Structures of this type can be designed with many types of materials and require a professional design person. Since these structures easily attract children and curious adults, safety features (fences, trash grids, or signs) need to be incorporated to avoid unnecessary harm.

[*Grade Stabilization Structure (410)*]

Gradient Terrace

Gradient terraces are earth embankments or ridge-and-channels constructed along the face of a slope at regular intervals. Gradient terraces are constructed at a positive grade. They reduce erosion damage by capturing surface runoff and directing it to a stable outlet at a speed that minimizes erosion. Gradient terraces are usually limited to use on long, steep slopes with a water erosion problem, or where it is anticipated that water erosion will be a problem. They should not be constructed on slopes with sandy or rocky soils. They are effective only when suitable runoff outlets are stable or will be installed. Adequate outlets could be grassed waterways, stable vegetated area, or a tile outlet. Terrace outlets should have a free flowing outlet, not submerged so as to force storage of surface runoff behind the terrace.

[*Terrace (600)*]

Grass-lined Channels (840)

A natural or constructed channel that is shaped or graded to required dimensions and established in suitable vegetation for conveyance of runoff to a stable outlet. The purpose of a grassed-lined channel is to convey and dispose of concentrated surface runoff without damage from erosion, deposition, or flooding. The practice applies to construction sites and developing areas where: 1) concentrated runoff will cause damage from erosion or flooding; 2) sufficient depth of soil materials to allow establishment of vegetation that will stabilize the cross section and grade of the channel; 3) channel grades are generally less than 5% slope; and 4) space is available for a relatively large cross section. Typical uses include roadside ditches, diversions outlets, and other channels and drainage swales to stabilize concentrated flows.

[*Grassed Waterway (412)*]

Gravel/Stone Filter Berm

A gravel or stone filter berm is a temporary ridge constructed of loose gravel, stone, or crushed rock. It slows and filters flow, diverting it from an exposed traffic area. Diversions constructed of compacted soil may be used where there will be little or no construction traffic within the right-of-way. They are also used for directing runoff from the right-of-way to a stabilized outlet. This method is appropriate where roads and other right-of-ways under construction accommodate vehicular traffic. Berms are meant for use in areas with gentle slopes and may also be used at traffic areas within the construction site. Spacing of berms is dependent upon slope steepness and length. Life-span is limited and requires frequent inspections and costly maintenance. Maintenance requires removal of sediment collected and replacing the stone/gravel berm to original design.

Impoundment Structure-Full Flow (841)

A dam or excavation which creates an impoundment to collect or store debris, sediment, or water. The purpose of this practice is to reduce sediment and/or debris in runoff waters preventing damage to downstream facilities, stream channels or banks, or to provide surface water for consumption, irrigation, wildlife habitat, recreation or fire

protection. The practice applies where sediment or debris is expected to be contained in runoff waters that may impair the capacity of the watercourse or damage other structures or where a surface water supply is desirable; where storage for at least one inch of water from the contributing watershed is either impractical or undesirable and where any embankment does not exceed the limits for dam classification and the landowner or responsible party has secured permits, if required, from federal, state and local governmental authorities.

[Grade Stabilization Structure (410); Structure for Water Control (578); Ponds (378)]

Impoundment Structure-Routed (842)

A dam or excavation which creates an impoundment to collect and store debris, sediment, or water. The purpose of this practice is to reduce sediment and/or debris in runoff waters preventing damage to downstream facilities or to provide surface water for consumption, irrigation, wildlife habitat, recreation or fire protection. The practice applies where sediment or debris is expected to be contained in runoff waters that may impair the capacity of the watercourse or damage other structures, or where a surface water supply is desirable, where storage for at least one inch of water from the contributing watershed is either impractical or undesirable and where any embankment does not exceed the limits for dam classification and the landowner or responsible party has secured permits, if required, from federal, state and local governmental authorities.

[Grade Stabilization Structure (410); Ponds (378); Structure for Water Control (578)]

Infiltration Basin (845)*

A dam designed to detain stormwater allowing it to slowly filter through the soil. Infiltration basins can be constructed to reduce the peak flow rate from the design storm, recharge groundwater in the vicinity of the basin, filter potential contaminants, and sustain flows during low stream flow periods. The basins are effective in removing contaminants from stormwater runoff in urban settings. Infiltration basins should be designed for each specific site. This practice is best used in larger intensively developed sites of 15 acres or less. Design criteria must include detention time ranges are from 24-72 hours; suitable soils with permeability ranges from 0.5 to 2.4 inches per hour to ensure proper infiltration and treatment of runoff; soils with less than 30% clay and less than 40% silt content; the basin floor should be nearly level; a stable outlet for the excess discharge; a plan to monitor for potential groundwater contamination; and a separation of 2-4 feet from the seasonal water table to avoid potential contamination.

[Sediment Basin (350); Structure for Water Control (578); Grade Stabilization Structure (410)]

Infiltration Trench (845)*

A shallow excavated trench backfilled with clean gravel or stone which intercepts stormwater runoff for temporary storage and infiltration. This practice reduces runoff volume and peak discharges from a site and filters contaminants out of runoff before it reaches the receiving waters in urban settings. Sediments must be filtered before the runoff water enters the trench using a designed filter strip. Infiltration trenches provide a good avenue to recharge groundwater in the local vicinity with permeable soils having silt and clay content below 40%. This permanent practice applies to small drainage areas,

usually 5 acres or less and sites with soils in the hydrologic groups A and B. Soils in hydrologic groups C and D will not perform adequately unless on a very small acreage. Infiltration trenches intercept internal drainage thus the need for an overflow outlet. All infiltration trenches need an overflow component since the trenches are not designed to handle large runoff volumes. These trenches require careful design and installation along with regular maintenance. Infiltration trenches are constructed 3 to 8 feet deep, lined with filter fabric, a sand filter, and backfilled with clean stone or gravel. Design for detention should have a range from 24-72 hours storing 2 inch of runoff/ impervious acre or the runoff volume from a 1 inch storm from the drainage area (maximum of 5 acres per designed trench) and the trench bottom a minimum of 2-4 feet above the seasonal high water table

[*Subsurface Drainage (606); Underground Outlet (620)*]

Inlet Protection-Block and Gravel (850)*

This is a sediment control barrier formed around a storm drain inlet using standard block and gravel. The purpose is to help prevent sediment from entering storm drains before the disturbed construction area is permanently re-vegetated and stabilized. This practice applies where early use of the storm drainage system is necessary. This method of inlet protection is effective where the inlet drains a small, nearly level area with contributing slopes generally less than 5%, where shallow sheet flows not exceeding 1 cubic feet per second are expected and the drainage area does not exceed 1 acre. The immediate land area around the inlet should be relatively flat, less than 1% slope, and located so that accumulated sediment can be easily removed. [This should not be used in areas receiving concentrated flows such as in street or highway medians.] Inlet protection is used in combination with other soil stabilizing measures to provide most effective sediment removal and longevity of the practice. Repairs and sediment removal should be performed on a regular schedule. Removal of such practices should not occur until the contributing drainage area is completely stabilized.

Inlet Protection-Excavated Drain (855)*

This is an excavated area used in the approach to a storm drain drop inlet or curb inlet. The purpose of this practice is to prevent sediment from entering storm drains before the contributing watershed is stabilized and allows early use of the storm system. This method is applicable where small storm events with relatively high sediment-laden flows are expected. Inlet design is for overflow capability and ease of maintenance are desired. This method of inlet protection is effective where the inlet drains a small, nearly level area with slopes generally less than 5%, where shallow sheet flows not exceeding 1 cubic feet per second are expected and the drainage area must not exceed 1 acre. The immediate land area around the inlet should be relatively flat, less than 1% slope, and located so that accumulated sediment can be easily removed. Frequent maintenance is required and temporary flooding in the excavated area will occur. [This should not be used in areas receiving concentrated flows such as in street or highway medians.] Inlet protection is used in combination with other soil stabilizing measures to provide most effective sediment removal and longevity of the practice. Repairs and sediment removal should be performed on a regular schedule. Removal of such practices should not occur until the contributing drainage area is completely stabilized.

Inlet Protection-fabric Drop (860)*

This is a temporary woven geotextile fabric barrier placed around a drop inlet. The purpose of this practice is to help prevent sediment from entering storm drains during construction operations. This practice allows early use of the storm drainage system. A fabric drop type inlet protection may be used where storm drain inlets are to be made operational before permanent stabilization of the disturbed drainage area. This method of inlet protection is effective where the inlet drains a small, nearly level area with slopes generally less than 5%, where shallow sheet flows not exceeding 1 cubic feet per second are expected and the drainage area must not exceed 1 acre. The immediate land area around the inlet should be relatively flat, less than 1% slope, and located so that accumulated sediment can be easily removed. [This should not be used in areas receiving concentrated flows such as in street or highway medians.] Inlet protection is used in combination with other soil stabilizing measures to provide most effective sediment removal and longevity of the practice. Repairs and sediment removal should be performed on a regular schedule. Removal of such practices should not occur until the contributing drainage area is completely stabilized.

Land Grading (865)*

Reshaping the ground surface to planned grades providing suitable topography for buildings, facilities and other land uses as determined by an engineered survey, evaluation, and layout. The purpose of this practice is to provide suitable topography for buildings, facilities, and other land uses to control surface runoff and minimize soil erosion and sedimentation both during and after construction. This practice is applicable where grading to a planned elevation is necessary to modify the site for the proposed development of a site and for proper operation of sedimentation control practices. Where practical, adapting the site to the existing landscape is preferable to reduce soil erosion and costly erosion and sediment control measures. Complementary practices that aid slope breaks include diversions (terraces or benches), temporary diversions, level spreaders, and slope drains (temporary or permanent) to reduce soil erosion on long continuous slopes.

[*Land Smoothing (466)*]

Level Spreader (870)

A non-erosive outlet for concentrated runoff constructed to disperse flow uniformly across a slope. The purpose of this practice is to convert concentrated flow to sheet flow and release it uniformly over a stabilized area. This practice is applicable where 1) sediment-free storm runoff can be released in sheet flow down a stabilized slope without causing erosion; 2) where a level lip can be constructed in a cut; 3) where the area above the spreader lip is uniform with a slope of 10% or less and is stable for anticipated flow conditions, preferably well-vegetated; 4) where the runoff water will not re-concentrate after release; and 5) where there will be no traffic over the spreader.

[*Diversion (362); Terraces, Level (600)*]

Lot Benching

Lot benching is the grading of lots within a subdivision so that the runoff from each lot is directed to a stable outlet rather than to an adjacent lot. This practice is applicable to subdivision developments on hilly or sloping topographic sites. Lot benching will reduce the slope and length of slope of disturbed areas within the development, thereby reducing the erosion potential. This practice establishes man-made drainage patterns on individual lots at the time of rough grading and later preventing drainage and siltation problems during construction. The degree of benefit depends upon the complementary conservation practices applied in combination with this practice such as seeding, mulching, waterways, and/or roadway swales. Lots benched on the upslope side of a lot with a 6% slope and 150 feet in length can achieve a reduction in sediment of 85%.

Mulching (875)*

The application of plant residues such as straw, grass, hay, wood chips, gravel, or other suitable materials to the soil surface. The purpose of this practice is as follows: 1) to prevent erosion and prevent surface compaction or crusting by protecting the soil surface from raindrop impact and reducing the velocity of overland flow; 2) to foster the growth of vegetation by conserving available moisture and providing insulation against extreme heat and cold; 3) to improve the site aesthetics; 4) to help maintain the infiltration capacity of the soil and 5) to control weeds. The practice is applied either as a temporary or permanent mulch. Temporary mulches are used to provide protection during temporary or permanent seeding establishment, such as when the season precludes seedling growth; for dust or mud control; and provide protection to areas during periods of construction when a seeding cannot be completed. Permanent mulches are used together with planting of trees, shrubs and other ground cover plants where vegetation does not provide adequate soil erosion protection, or it is used in lieu of vegetative planting for ornamental reasons or because the site is unsuitable for vegetation. Care must be exercised in selection and purchase of weed-free mulch so as to not introduce unknown noxious weeds. Mulches when used in combination with seeding or planting aids in plant growth by modifying the growing environment and holds the seeds, fertilizers and topsoil in place. Use of a mulch may require a binder, netting, or a tacking substance to hold the mulch close to the soil surface. Mulch slopes of 2:1 or steeper, where runoff is flowing across the area, or when seedlings need protection from adverse growing conditions. Hydro-mulching commonly used with hydro-seeding as alternative to sodding or in hard to reach areas for standard seeding and mulching equipment. Hydro-mulching uses wood fiber or other cellulosic fiber such as processed newspaper to produce a uniform fibrous state. It generally is sprayed onto the soil surface as a slurry in water along with seed, fertilizer, lime, binders, and any other additives kept in suspension by agitation
[*Mulching (484)*]

Oil/grit Separators

Oil/grit separators are chambers designed to remove sediment and hydrocarbons from urban runoff. These are used close to the source of potentially contaminated runoff before being conveyed to stormwater drains or infiltration trenches/basins. Separators are generally used where heavy traffic or high potential for petroleum spills can occur such

as parking lots, gas stations, roads, and loading areas. The separators remove floating oil and coarse sediments from runoff. Detention is brief thus removal has limited effectiveness. Soluble pollutants will most frequently pass through the separators. Separators most commonly are installed below the surface, close access to stormwater drains, and have easy access for maintenance. Separators are designed with three chambers with 400 cubic feet/surface area drained. More recent separators use a synthetic medium that has a greater attraction for floating oils and solubles substances, however, it is more costly to maintain.

Porous Pavement (890)

A pavement consisting of strong structural materials having regularly interspersed void areas which are filled with pervious materials, such as sod, gravel, or sand. The purpose of this practice is to reduce water pollution from low-volume traffic areas by providing a bearing surface having adequate strength to accommodate vehicles while allowing infiltration of surface water and filtration of pollutants. The practice is intended to achieve this purpose by 1) reducing volume and peak rate of runoff flow, thus reducing the likelihood of stormdrain overflows, flooding, and downstream erosion and sediment deposition and 2) reducing the loading and concentration of pollutants in the runoff. This applies to the following conditions where the underlying soil allows for rapid drainage but does not contaminate underground water. It may be used in 1) parking lots especially fringe or overflow areas; 2) parking aprons, taxiways, blast pads, and run-way shoulders at airports; 3) emergency stopping and parking lanes and vehicle cross-overs on divided highways; 4) off-street parking aprons in residential settings; 5) recreational vehicle camping area parking pads; 6) private roads, easement service roads, and fire lanes; 7) industrial storage yards and loading zones (heavier loads may demand use of reinforced grid systems need; 8) driveways for residential and light commercial use; and 9) bike paths, walkways, patios, and swimming pool aprons.

Portable Sediment Trap (895)

A compartmented container through which sediment-laden water is pumped to trap and retain the sediment. The purpose of this practice is to trap and retain sediment prior to pumping the water to drainage-ways, adjoining properties, and right-of-ways below the sediment tank site. A sediment tank is to be used on sites where excavations are deep and space is limited, such as urban construction, where direct discharge of sediment-laden water to stream and storm drainage systems is to be avoided. It is also used where an excavation extends below the seasonal water table causing a sump pump to be used.

Preservation of Natural Vegetation

Preservation of natural vegetation (existing trees, vines, brush, and grass) provides natural buffer zones. By preserving stabilized areas it minimizes erosion potential, protects water quality, enhances aesthetics, and provides wildlife benefits. This practice is used as a permanent control measure. This technique is applicable to all sites but is especially applicable to areas such as floodplains, wetlands, streambanks, steep slopes, sinkholes, and other areas where erosion control would be difficult to re-vegetate, install, or maintain the vegetation. Preservation of the vegetation should be planned before any site disturbance begins, preferably before site plan approval has been received from local

zoning and planning agencies. Good site management minimizes the impact from construction activities by clearly marking the boundaries for trees and other vegetation to be protected including the root structure. Maintenance is critical to the survival of healthy vegetation and provides effective water quality benefits. Maintenance requires regularly scheduled inspections and execution of maintenance items such as fertilizing, mowing, pruning, weed and pest control. Local and state regulations may require more stringent site specific management plans which must be adhered to.

[*Riparian Forest Buffer (391)*; *Wildlife Upland Habitat Management (645)*; *Wildlife Wetland Habitat Management (644)*]

Retaining Walls*

A constructed wall used to eliminate steep slopes between areas that have abrupt changes in grade. This practice is used to replace cut or fill slopes in confined areas or where a wall is necessary to stabilize slopes. Retaining walls can be constructed of reinforced concrete, treated timber, gabions, reinforced earth (system of face panels and buried reinforcement strips), or other manufactured products such as inter-locking concrete blocks. Each site is unique and requires detailed site plans for drainage, anchors, foundation, and backfill requirements.

Right-of-way Diversion (Water Bars) (900)*

A temporary or permanent ridge or ridge and channel constructed diagonally across a sloping road or utility right-of-way that is subject to erosion. It is designed to shorten the flow length within the sloping area. The purpose of this practice is to limit the accumulation of erosive volumes of water by diverting surface runoff at pre-designed intervals to a stable outlet. This practice applies where runoff protection is needed to prevent erosion on sloping access right-of-ways or other long, narrow sloping areas, generally less than 100 feet in width with a slope of 2% or less for an outlet. It generally is constructed of compacted soil or aggregate or a combination. Spacings are based on slope of right-of-way and range from 25-125 feet between the constructed ridges. Depending upon usage, these diversions require regular inspections and maintenance.

Riprap Lined Channel*

Waterways with an erosion-resistant rock lining designed to carry concentrated runoff to a stable outlet. This practice applies where conditions are expected to be unstable for use of grass-lined channels, such as 1) channels with average grades greater than 5%; 2) where continuous or prolonged flows occur; 3) potential for damage from traffic exists; 4) soils are erodible; 5) soil properties are not suitable for sustained vegetative growth; 6) design velocities exceed 5 feet per second; 7) channel location warrants the use of increased protection; and 8) channel will have prolonged periods of wetness which will hinder adequate growth of permanent grass vegetative cover.

[*Grassed Waterway (412)*; *Lined Waterway/outlet (468)*]

Rock Dam*

A stone embankment with woven geotextile fabric designed to capture sediment on the construction site and prevent off-site sedimentation into streams, lakes, wetlands, and drainageways. This practice can be used as an alternative to a standard sediment basin for locations with a drainage area of 5 acres or less. It may be preferable to standard sediment basins for sites where an earthen embankment would be difficult to construct. [Maximum height of constructed embankment is 8 feet with a maximum life-span of 3 years or less.] A zero grade riprap apron for outlet protection may be required to provide outlet stability. Maintenance is required after a significant storm event.

Rock Outlet Protection (910)*

A section of rock protection placed as a zero grade (level) rock apron at the outlet end of culverts, conduits, or channels (interceptor dikes, swales, diversions, terraces, etc.). The purpose of this practice is to prevent scour erosion at stormwater outlets; to protect the outlet structure; and to minimize the potential for downstream erosion by reducing the discharge velocity and energy of concentrated stormwater flows that exceed the permissible discharge velocities of the receiving area. The outlet protection may require the use of a plunge pool to dispel more energy with greater efficiency by using it in combination with the apron. The practice also reduces the effects of turbidity and sedimentation. This is applicable where the discharge velocities and energies at the outlets of culverts, conduits, or channels are sufficient to erode the receiving drainageway. This could be 1) culvert outlets of all types; 2) pipe conduits from, dry or wet, sediment basins and stormwater detention basins; 3) new channels constructed as outlets for culverts and conduits; and 4) outflows from conduits or channels that do not exceed 12 feet per second. [Does not apply to continuous rock linings of channels, streams or slopes steeper than 10 percent where reconcentration of flows is encountered.] This type of protection can be achieved using riprap, concrete aprons, paved sections, and settling basins installed below the storm drain outlet.

[Lined Waterway/outlet (468)]

Sediment Basin, Permanent (960)*

A constructed barrier or dam with a controlled stormwater release structure formed by constructing an embankment of compacted earth fill across a drainageway. This practice applies where erosion control measures are insufficient to prevent off-site sedimentation. The purpose of a sediment basin is to detain sediment-laden runoff from disturbed areas in wet or dry storage long enough for most of the sediment to settle out. This practice applies at 1) outlets of diversions, channels, slope drains, or other runoff conveyances that discharge sediment-laden water; 2) below drainage areas that are 20 acres or less and does not exceed a maximum dam height of 10 feet; 3) where access can be maintained for sediment removal and proper disposal; 4) in the approach to a storm water inlet located below a disturbed area as part of an inlet protection system; 5) outlet from basin has a stable outlet using a zero grade riprap apron; 6) maximum structure life-span is 10 years with a drainage area of 20 acres or less with a minimum of 24 hour detention time and 7) where failure of the structure will not result in loss of life, damage to homes, commercial or industrial buildings, main highways or railroads, or in the use or service of public utilities. Structure must meet all local, state and federal dam safety requirements plus

safety concerns such as fencing. A sediment basin when used in combination with other control measures is quite effective in sediment removal.

[*Sediment Basin (350); Water and Sediment Basin (638)*]

Sediment Basin, Temporary (960)

A small, temporary ponding basin formed by construction of an embankment or excavated basin to capture sediment. The purpose of this practice is to detain sediment-laden runoff from disturbed areas for a sufficient period of time to allow the majority of sediment and other water-based debris to settle out so as to protect streams, lakes, wetlands, drainage systems, and adjacent property during construction activities. This practice applies at 1) outlets of diversions, channel, slope drains, or other runoff conveyances that discharge sediment-laden water; 2) below drainage areas that are 5-20 acres and does not exceed a maximum dam height of 10 feet; 3) where access can be maintained for sediment removal and proper disposal; 4) in the approach to a storm water inlet located below a disturbed area as part of an inlet protection system; 5) structure life of less than 18 months; 6) outlet from basin has a stable outlet using a zero grade riprap apron; and 7) where failure of the structure will not result in loss of life, damage to homes, commercial or industrial buildings, main highways or railroads, or in the use or service of public utilities. [This is not intended to be a permanent structure.] Structure must meet all local, state and federal dam safety requirements plus safety concerns such as fencing. A sediment basin when used in combination with other control measures is quite effective in sediment removal. A well designed and construct temporary basin that is designed to handle post-construction runoff volume may be converted to a permanent stormwater management structure.

[*Sediment Basin (350); Water and Sediment Basin (638)*]

Sediment Trap, Temporary (960)*

A temporary ponding basin formed behind an embankment or excavation to capture sediment. The purpose of a temporary sediment trap is to hold sediment-laden runoff, trapping the sediment. This practice protects receiving streams, wetlands, lakes, drainage systems, and adjacent property during construction activities. Temporary sediment traps apply wherever sediment-laden runoff is discharged, such as outlets of diversions, channels, stormwater conduits and slope drains, that have a stable outlet using a zero grade riprap apron. Maximum drainage area is 5 acres or less. [This is not intended to be a permanent structure (maximum life-span of 2 years and not greater than 5 feet of embankment fill.)] Traps should be regularly inspected and sediment removed when 50% of the sediment storage capacity has been reached to maintain the life of the structure and meet the discharge restraints in the permit.

[*Sediment Basin (350); Water and Sediment Basin (638)*]

Seeding, Permanent (880)*

Establishing permanent vegetative cover on un-stabilized areas and these areas will remain unprotected for 12 months or more. The purpose of this practice is to provide economical long-term reduced erosion control and decrease sediment movement from disturbed areas, and to permanently stabilize such areas in a manner that adapts to site conditions and allows selection of the most appropriate materials. It applies to disturbed

areas where long-lived vegetative cover is needed to stabilize soil and on other areas where cover is desired. This is especially important where soils are unstable due to soil texture, structure, slope steepness, or depth of soils is limiting. Plant materials are selected based on climate, topography, soils, slope, aspect, potential land use, available light, aesthetics, and maintenance. It is a very necessary component to protect constructed earthen structures such as dikes, diversions, channels and embankments, waterways, earthen dams, filter strips, steep slopes, streambanks, and road banks to prevent erosion. Particular care is required to establish a high quality permanent vegetative cover that is enduring and thick. To ensure a quality stand, take a soil test, then apply and incorporate only those soil amendments determined by the test for the plants need.

[*Critical Area Seeding (342); Mulching (484)*]

Seeding, Temporary (965)

It is the establishment of a fast-growing, short-term (annual) vegetation to provide economical erosion control for up to 12 months and reduce the amount of sediment and other potential pollutants from moving off-site. Annual plants (annual grasses and cereal grains) which sprout rapidly and survive for only one growing season are suitable for establishing temporary vegetative cover and erosion control on disturbed areas. The purpose of this practice is to temporarily stabilize denuded areas that will not be brought to final grade or when construction will be stopped for a period of greater than 14 days. Temporary seeding helps reduce runoff and erosion until permanent vegetation or other erosion control measures can be established. In addition, it provides residue for soil protection during seedbed preparation and reduces problems of mud and dust production from bare soil surfaces during construction. This is applicable to all cleared, unvegetated, or sparsely vegetated soil surfaces where vegetative cover is needed for 1 year or less. If further delays occur due to weather, reseed again after 12 months to ensure adequate protection of the disturbed areas. This applies to earthen structures such as dikes, diversions, dams, temporary sediment basins, temporary road banks, topsoil stockpiles, and any other exposed areas of a construction area or site. It applies where short-lived vegetation can be established before final grading or in a season not suited to permanent seeding. It helps prevent costly maintenance operations of other erosion control systems such as a sediment basin clean-out. To ensure a quality stand, take a soil test, then apply and incorporate only those soil amendments determined by the test for the plants need.

[*Cover and Green Manure Crop (340); Mulching (484); Critical Area Seeding (342)*]

Silt Curtain, Flotation

A flotation silt curtain is a silt barrier used within a lake, pond, reservoir, or wetland. The flotation silt curtain consists of a filter fabric curtain weighted at the bottom and attached to a flotation device at the top. This structure is used to isolate an active construction area within a body of water to prevent silt-laden runoff water from migrating away from the construction zone and damaging environmentally sensitive areas. This is very effective for limiting the migration of suspended sediment within the body of water but it will not reduce the amount of disturbance from work performed within the water except to minimize the area effect. These curtains are attached to a floating tube on the water

surface with cables anchored into stable shoreline. This device should be maintained until such time when the disturbed area is stabilized and turbidity in the water has reached acceptable water quality standards. Prior to any design or proposed work that may exceed limits within the water body be sure to obtain all required permits from local, state or federal regulatory agencies.

Silt Fence (920)

A temporary barrier of entrenched woven geotextile fabric (filter fabric) stretched across and attached to supporting posts used to intercept sediment-laden runoff from small drainage areas (maximum of 1/4 acre per row of silt fence) of disturbed soil. The purpose of this practice is to cause deposition of transported sediment load from sheet flows leaving small disturbed areas. Silt fences may also prevent sheet erosion by decreasing runoff velocities. A silt fence is subject to limitations based upon maximum slopes, slope lengths, drainage areas, erosion from sheet erosion only. It should not be used for concentrated runoff flowing towards the barrier. To maximize efficiency, install the silt fence on the contour, not across gullies or concentrated flows. Use is applicable when the disturbed area remains exposed for 6 months or less but not exceeding one construction season. It may be used as a component for storm drain inlet protection. Silt fences need weekly inspections and maintenance after each stormwater runoff event. The life expectancy of a silt fence is most dependent upon the type of material used.

Slope Drain, Temporary (970)

A flexible tubing or rigid conduit extending temporarily from the top to the bottom of a cut or fill slope face. The purpose is to convey concentrated runoff down the face of a cut or fill slope without causing erosion on or below the slope. This practice applies to construction areas where stormwater runoff above a cut or fill slope will cause erosion if allowed to flow over the slope face. Temporary slope drains are generally used in conjunction with temporary diversions or diversion dikes to convey runoff down a slope to a stable outlet or a sediment basin. These should be used until such time when a permanent water disposal measure(s) can be installed, which may be converted to a permanent slope drain with a stable outlet (generally installed below the surface for future protection). Temporary pipes or conduits may be converted to paved chutes, metal, plastic, concrete, or clay conduits. The maximum drainage area should be 5 acres per drain. Any drainage area greater than one acre requires site specific design before installation. This practice is used in combination with level spreaders, diversion dikes or swales, or sediment traps.

[*Subsurface Drainage (606); Underground Outlet (620)*]

Sodding (925)*

Stabilizing final graded disturbance areas by laying a continuous cover of grass sod. The purpose is to prevent erosion and damage from sediment by stabilizing the soil surface and to improve the visual quality and utility of the area quickly. The practice is applicable where 1) the disturbed area requires immediate cover for erosion protection and sediment control such as slopes and filter strips; 2) where sodding is preferred to other means of grass establishment; 3) in residential or commercial areas where quick use or aesthetics are a factor; 4) places where surface water concentrates, such as, diversions,

swales or grassed-lined waterways carrying intermittent flows; 5) areas around drop inlets, stormwater detention basins, or in swales; and 6) any area where conditions make seeding impractical or impossible. Such examples of areas in need of quick establishment using sod are buffer zones, streambanks, road ditch banks, waterways, diversions, inlets to drainage systems, dikes, swales, steep slopes, filter strips, or level spreaders. Soil test the site then apply and incorporate the necessary soil amendments to ensure adequate nutrients to re-establish the sod for sustained growth. This method of establishing permanent cover can be used any time of the year except when the soil is frozen. Where concentrated water flows will flow over the sod, use one of several staking methods to hold sod in place until established.
[*Critical Area Seeding (342)*]

Soil Bioengineering for Slope Protection*

The use of live, woody vegetative cuttings to increase slope stability and repair slope failures such as shallow sloughs or slides. When the vegetative cuttings are placed in the ground, roots develop and foliage sprouts. These live woody cuttings can be live stakes, live fascines, brush-layers, or branch-packing. Soil bioengineering has the benefits of temporary and permanent vegetation to reduce erosion; off-site sedimentation; runoff; velocities; increased consumption of internal soil moisture; and increased infiltration. As the woody vegetation grows roots mechanically reinforce the soil providing greater protection than grass or a mechanical measure alone. Two approaches can be used 1) woody vegetation systems and 2) woody vegetation systems combined with simple inert structures. The structural portion allows for establishment on steep slopes or areas subject to extreme erosion from off-site to be protected. Both systems are effective and must be designed for site specific conditions. These systems grow stronger with time increasing the root holding power as trees and shrubs mature. The greatest advantage of this system is that this method can be applied to small sites where access by equipment is limited and limited access by animals can be achieved; to environmentally sensitive areas; and where minimal site disturbance is needed to establish. It is particularly suited for small, highly sensitive or steep slopes. Most techniques can also be used for stream channel or bank protection, and once it establishes (matures), most woody vegetation becomes self-repairing and needs little maintenance. Live woody cuttings in combination with porous, inert structural materials help create live crib walls, vegetative rock gabions, or joint plantings that stabilize slopes and improve erosion control.

[*Stream Channel Stabilization (584); Streambank And Shoreline Protection (580)*]

Stabilized Construction Entrance/exit Pad (930)*

A stabilized pad of stone base aggregate underlain with woven filter fabric located where construction vehicles can drop their mud to avoid transporting it directly onto a public right-of-way, road, street, alley, sidewalk, parking area, or other paved area. The purpose of this standard is to reduce or eliminate the tracking of sediment onto public right-of-ways or streets. This may be used in combination with other practice measures to accomplish the specific site or area needs. A stabilized construction entrance shall be used at all points of construction ingress or egress. This should not be used as an equipment washing site unless special provisions have been made for the collection of

wash-water. A permit may be required if such wash water is not properly collected and treated by a public water treatment system facility.

[*Access Road (560)*]

Stormwater Wetland, Urban (800)

A constructed system of shallow pools, wet ponds, and retention/detention ponds that create growing conditions suitable for emergent and riparian wetland plants, explicitly designed to lessen the impacts from stormwater quality and quantity in urban areas.

Stormwater wetlands are designed and installed to maximize pollutant removal (sediment, trace metals, nutrients, hydrocarbons, harmful pathogens, and other oxygen demanding substances). Stormwater wetlands create wetland habitat through the creation of a matrix of water, sediment, nutrients, plants, and detritus that collectively provides temporary (detention time of 72 hours) storage of urban stormwater runoff. The wetland is designed to remove multiple pollutants from source water through a series of complementary physical, chemical, and biological pathways. This practice applies to urban or urbanizing watersheds where stormwater quality and quantity control is needed to meet the diverse management objectives of developers and local governing units.

Wetlands can be typically constructed as an embankment across a valley, by constructing a perimeter berm, or by excavating a shallow basin in natural soil as a specific component of several urban multi-purpose stormwater management structures. Stormwater wetlands require from 6-10 acres of drainage for each acre of wetland created and require soils of low to moderate permeability (hydrologic soil groups C and D). Stormwater wetlands also require additional design storage for sediment at the wetland entrance should account for 20-40 years of sediment accumulation from the wetland drainage area. Stormwater wetlands require more management during the first three years to establish wetland conditions. Thereafter, maintenance requirements are similar to wet ponds. Stormwater wetlands typically are not located within delineated natural wetland areas. Natural wetlands provide critical habitat and ecosystem benefits and are protected under local, state, and federal statutes. Natural wetlands also can be ecologically damaged due to the increased sediment delivered. Stormwater wetlands differ from artificial or created wetlands because they lack the ecological functions of natural wetlands. Stormwater wetlands should not be confused with created or restored wetlands that are used to mitigate the loss of natural wetlands under permitting provisions of wetland protection. Wetlands (natural or constructed) require large acreage to be effective for water quality benefits.

[*Grade Stabilization Structure (410); Ponds (378); Structure for Water Control (578)*]

Straw Bale Barrier (935)

A temporary barrier consisting of a row or more of entrenched and anchored straw bales on the contour or similar material may be used to intercept sediment-laden runoff from small disturbed drainage areas. The purpose is to cause deposition of transported sediment from sheet flow leaving disturbed areas. Conditions for use are dependent upon maximum slope, slope length, and a drainage area (not greater than 1/4 acre). Sediment must be from sheet and rill erosion only, with no concentration of water flowing to the barrier, and the life span is 3 months or less until vegetative establishment. Straw bale barriers may be used across minor swales in watersheds, 2 acres or less of drainage area,

when the expected sediment-laden runoff is minimal, the topography is 2% or less slope and the slope length is 100 feet or less. It does not apply where soil is not sufficient to fully anchor the straw bales (rock or other hard surface).

Stream Crossing, Temporary (975)*

A bridge, ford, or temporary structure installed across a stream or watercourse for short-term use by construction vehicles or heavy equipment. The purpose of this practice is to provide a means for construction vehicles to cross streams or watercourses without moving sediment into streams, damaging the streambed or channel, or causing upstream flooding. This applies where heavy equipment must be moved from one side of a stream channel to another, or where light-duty construction vehicles must cross the stream channel frequently for a short period of time. Generally, a temporary stream crossing is applicable to flowing streams with a drainage area of less than 1 square mile. For larger drainage areas, a more exacting design is required. Temporary stream crossings can be designed as low water crossings, as an embankment with a culvert, or as a bridge with or without embankment approaches. Properly constructed crossings prevent turbidity and streambed disturbances. All stream crossings require the design assistance of a professional design engineer. All appropriate permits must be obtained from local, state and federal jurisdictions prior to installation of in-stream structures.

Streambank Setback*

The practice of limiting vegetation removal and grading of the riparian area along flowing waters. This practice is intended to protect the banks of natural streams from damage due to development, lessen the risk of flooding in developed areas and provide a buffer between the developed area and the stream. A properly maintained streambank setback will help maintain channel capacity and stability, reduce the sediment load in the channel and reduce the movement of potential contaminants into the stream. Setbacks help preserve natural channel meander and protect homes and other buildings from damage due to bank erosion. Streambank setbacks can also apply to areas adjacent to excavated open channels used for site drainage, drainageways, and watercourses that route stormwater runoff to streams. Prior to establishment of setback consult with the Federal Emergency Management Agency (FEMA) and other local and state agencies having regulatory control of floodplain management to determine the 100-year floodplains. A minimum distance of 50 feet from the streambank top. Where channel down cutting is occurring, a greater setback distances (100 feet if space exists) may be needed or is required. Maintenance of the streambank setback is an ongoing effort that requires inspections after major storm events to maintain quality cover while removing log jams that will damage streambanks or cause flooding.

[Riparian Forest Buffer (391); Wildlife Upland Habitat Management (645); Wildlife Wetland Habitat Management (644)]

Streambank Stabilization (940)

Stabilization of eroding streambanks by use of designed vegetative, structural, or a combination of both methods. The purpose is to protect streambanks from the erosive forces of flowing water. It is often necessary in areas where development has occurred upstream and full channel flow occurs several times each year. This practice is

applicable to sections of streambanks that are subject to erosion due to excessive runoff from pre-development and/or proposed construction activities. Generally it is applicable where flow velocities exceed 5 feet per second or where vegetative streambank protection is inappropriate. Vegetative protection is the least costly and the most compatible with natural stream characteristics, but is not effective where stream hydrology shifts are occurring. Since each reach of channel requiring protection is unique, measures for structural streambank protection should be evaluated and installed according to a plan based on the specific site conditions and designed by a professional engineer. Considerations in determining which type of streambank protection to use include: 1) current and future watershed conditions; 2) sediment load; 3) channel slope; 4) control of bottom scour; 5) soil conditions; 6) present and anticipated channel roughness; 7) compatibility with other improvements; 8) changes in channel alignment; 9) fish and wildlife habitat; and 10) future maintenance obligations. Measures that can be used singularly or in combination are 1) vegetative protection (grass, shrubs, trees, and aquatic plants) and 2) structural protection (riprap, rock armor, gabions, fabric formed revetments, log cribbing, reinforced concrete, grid pavers, cellular confinement matrices). All appropriate permits must be obtained from local, state and federal jurisdictions prior to installation for in-stream modifications.

[*Stream Channel Stabilization (584); Streambank And Shoreline Protection (580)*]

Subsurface Drain (945)

A conduit, such as corrugated plastic tubing, tile, perforated pipe, or continuous layer of porous material installed below the ground surface that intercepts, collects and/or conveys excess drainage water to a stable outlet. [***Subsurface drains by themselves provide no water quality benefits.***] This practice applies where ground water is at or near the soil surface and adequate surface drainage cannot be provided via safe surface runoff. There are two types of subsurface drains, relief drains and interceptor. Relief drains dewater an area where the water table is high. Interceptor drains are used to remove water where sloping soils are excessively wet and/or subject to soil slippage caused by hillside seeps. The purpose is to 1) improve the soil environment for vegetative growth and promote soil stability, thus reducing erosion and improving water quality; 2) collect ground water for beneficial uses, 3) remove water from heavy use areas, such as around buildings, roads, play areas, and accomplish other physical improvement related to water removal, and 4) regulate water to control health hazards caused by pests such as liver fluke, flies, or mosquitoes. Indirect water quality benefits include 1) regulating the water table and ground water flows, 2) intercepting and preventing water movement into a wet area, 3) relieving artesian pressures, 4) removing surface runoff, and 5) leaching of saline and sodic soils. This practice applies to areas having a high water table where the benefits of lowering the water table or controlling ground water or surface runoff justifies installation and associated costs. The soil should have adequate depth and permeability to be effective when installed. The site should have a suitable outlet for the quantity and quality of effluent discharged from the drain.

[*Subsurface Drainage (606)*]

Sump Pit (950)

A temporary pit which is constructed to trap and filter water for pumping into a suitable discharge area. The purpose of this practice is to remove excessive water from excavations in a manner that improves the quality of water being pumped. Sump pits are constructed when water collects during the excavation phase of construction, especially excavation of building foundations.

Surface Roughening

Surface roughening is a temporary erosion control practice. The soil surface is roughened by the creation of horizontal grooves, depressions, or steps that run parallel to the contour of the land. Slopes that are not fine-graded and that are left in a roughened condition can also control erosion. Surface roughening reduces the speed of runoff, increases infiltration, and traps sediment. Surface roughening also helps establish vegetative cover by reducing runoff velocity and giving seed an opportunity to take root and grow. It is appropriate for all slopes. This should be done as soon as possible after the original vegetation has been removed from the slope. It should be used immediately after final grading activities have ceased. This can be applied using stair-step grading, grooving (disks, spring harrows, or teeth on a front-end loader), and tracking (driving a crawler tractor up and down the slope, leaving cleat imprints parallel to the slope contour). This practice applies to slopes flatter than 2:1.

[*Surface Roughening (609)*]

Swale, Temporary (980)*

A linear depression in the ground surface which carries drainage runoff but does not block traffic as do ditches, gutters, or diversions. This practice applies anywhere a drainage conveyance is required and can be used as an alternative to closed pipe systems. Grassing the swales also provide the benefits of reducing storm water velocity, promoting infiltration and removing sediment. The design drainage area should be less than 3 acres and a graded channel that will not erode when the soil is bare.

[*Surface Drainage, Field Ditch (607)*; *Lined Waterway/outlet (468)*]

Top Soiling (981)

Preserving topsoil prior to construction and using it after construction to aid in vegetation establishment on the construction site. Methods of preserving and using topsoil to enhance the final site stabilization with vegetation. The purpose of this practice is to provide a suitable growth medium for final site stabilization with vegetation. This practice applies where 1) the preservation or importation of topsoil is determined to be the most effective method of providing a suitable growth medium; 2) where the subsoil or existing soil present any or all of the following problems; a) physical and chemical properties such as texture, bulk density, pH, or nutrient balance of soil cannot be modified; b) the soil is too shallow to provide adequate rooting depth or cannot supply ample moisture or nutrients for desired vegetative growth; and c) the soil contains toxic or potentially toxic substances; and 3) where high-quality turf or ornamental plants are desired. This practice applies to areas on a site that will be disturbed by excavation, compaction or filling, and to areas where the subsoil is unsuitable for plant growth. A minimum of 24 inches of combined topsoil and subsoil is needed for adequate vegetative

growth. A soil test should be taken and necessary soil amendments added and incorporated to correct soil deficiencies. Soil test the topsoil then apply and incorporate necessary soil amendments to ensure adequacy to establish and sustain vegetative growth or other intended uses.

[*Critical Area Seeding (342); Spoilbank Spreading (572)*]

Tree and Shrub Planting (985)

Planting selected trees and shrubs in the soil. The purpose of this practice is to establish trees and shrubs to conserve soil, beautify an area, screen unsightly views, provide shade, conserve energy, and attract wildlife. This practice applies in urban environments where woody tree and shrub species are needed to protect the soil from erosion, where ornamental plants are desirable for landscaping and beautification and where woody plants are needed to screen unsightly views, reduce noise levels, conserve energy, or provide wildlife food and habitat. When planting woody plants species, consideration should be given to utilities above and the below ground surface for safety and health reasons.

[*Tree Planting (612); Hedgerow Planting (422)*]

Tree and Shrub Protection (990)*

Preserve and protect trees during development for their aesthetic and economic value, and their aid in energy conservation, landscaping, air purification, bank or slope stabilization, and erosion control. The purpose is to preserve and protect desirable trees and shrubs that have present and/or future value for erosion protection, for landscape and aesthetic value, or for other environmental benefits. This practice applies on all development sites containing stands of desirable trees and shrubs. Trees and shrubs can be damaged or killed by direct contact with construction equipment, compaction of the soil within the root zone of the tree or shrub, filling of subsoil or topsoil around tree bases to cause suffocation of roots and the plant, changes in elevation of the water table due to site grading, and from construction chemicals and refuse. Although damage may be unseen, it can result in the eventual death of the tree within 3-4 years. Root zone damage is the leading factor of unintentional death. A thumb rule for protection of the critical root zone would be to keep all activities (excavating, traffic, or storage sites) outside of the tree canopy drip-line.

[*Forest Stand Improvement (666); Tree Planting (612); Hedgerow Planting (422)*]

Vegetative Streambank Stabilization (995)

The stabilization and protection of eroding streambanks with selected vegetation. The purpose is to protect streambanks from the erosive forces of flowing water and provide a natural, pleasing appearance. This applies to natural or excavated channels where the streambanks are susceptible to erosion from the action of flowing water, ice or debris and the problem can be solved using vegetative measures. Vegetative stabilization is generally applicable where bankfull flow local velocity does not exceed 5 feet per second and the soils are erosion resistant. Any soils not erosion resistant and where local velocities exceed 5 feet per second at bankfull need structural measures. All necessary permits must be obtained from local, state, or federal jurisdictions prior to installation.

[*Stream Channel Stabilization (584); Streambank And Shoreline Protection (580)*]

OTHER MEASURES

Forested Riparian Buffer

[Riparian Forested Buffer (391)]

IN-STREAM MEASURES

Eddy Rocks

Deflectors (Jetties)

Gravel Riffles (New Channel Stabilization)

Multi-stage Channel (Low Flow Augmentation)

Vortex Rock Weir (Grade Stabilization)

GOOD HOUSEKEEPING PRACTICES

Good housekeeping is basically keeping a clean, orderly construction and industrial site. One of the first steps towards preventing stormwater contamination is improving house keeping practices listed below and using good common sense. Good housekeeping practices reduce the possibility of accidental spills, improve the response time if there is a spill, reduce safety hazards as well, and improve the overall appearance of the construction site.

Accidental Spills

Spills are a source of stormwater contamination within construction sites. Spills contain soil, water, and waste materials that can produce potential health risks to the environment. Spills should be dealt with quickly and effectively to reduce the overall impact on water quality and the environment. Construction precautions should develop a spill plan to stop the source of the spill, contain the spill, clean up the spill, dispose of the contaminated materials, and identifies capable individuals and agencies to minimize the impact from a spill. Store and handle materials to prevent spills and reduce the potential for stormwater contact. Allow only authorized personnel to obtain, handle, and secure materials that can pose a problem.

Concrete Trucks

Most construction projects include some sort of concrete work. Usually, concrete is premixed offsite and delivered. The concrete is poured and residual amounts of concrete mix remain in the truck, or occasionally, excess concrete is delivered, or the concrete is rejected and thus dumped. Emptying or wash out of excess concrete may be allowed onsite. However, it should be disposed of in a manner that prevents contact with stormwater runoff discharged from the site into a stream. Dikes or sumps could be constructed to contain these concrete materials until it solidifies and then can be properly handled and disposed. Concrete mixes contain various substances which should not be allowed to contaminate runoff water.

Contaminated Soils

Contaminated soils are soils which have been exposed and still contain hazardous substances. Contaminated soil may be encountered onsite during earthmoving activities or during the cleanup of a leak or spill of hazardous product. Material storage areas may also have been contaminated by undetected spills where the nature of the contaminants may or may not be known. Contact the local or state regulatory agency for the proper protection, treatment, or disposal of these contaminated soils.

Control of Allowable Non-storm Water Discharges

Most stormwater permits do not include the discharge of non-storm water discharges. The following list of non-stormwater discharges are typically allowed: 1) discharges from fire fighting activities (where previous discussed contaminants have not been used, stored, or spilled); 2) fire hydrant flushing; 3) potable water line flushing; 4) uncontaminated ground water (dewater); 5) foundation or footer drain not contaminated with process materials such as solvents; 6) springs, riparian habitats, and wetlands; 7) irrigation water; 8) exterior building wash down (if only water is used - no cleaning solutions); 9) pavement wash waters; and 10) air conditioning condensate.

Construction Wastes

Construction wastes are numerous depending upon the site. Construction materials include packaging materials (wood, paper, plastics, etc.), trees and shrubs from clearing and grubbing the site, scrap or surplus building materials (scrap metals, rubber, plastic, masonry products, glass, and other solid waste materials), paints and paint thinners, and rubble (materials resulting from demolition). Those materials (non-native) which are easily removed should be properly disposed in approved landfills and/or recycled. Other permissible materials may be properly disposed on site provided it does not impede the flow or pollute public waters, fill stormwater retention areas (wetlands or depressions), or impair visual appearances on the landscape.

Dewatering

Dewatering is the method used to remove and discharge excess water from a construction site. Most commonly this is accomplished using a pump where natural gravity does not occur. Otherwise it occurs through normal drain off into sediment traps, sediment basins or graded outlet (excavated areas). The most common application is to lower a high water table which will stabilize the construction site and permanent facilities being installed. Dewatering may be used during construction to remove accumulated water and sediments from sediment traps and basins as part of a maintenance schedule. Filtering should be provided when discharging from such facilities since the water generally contains high sediment content and other possible floating debris.

Fertilizers/Detergents

Nutrients such as phosphorous and nitrogen are found on construction sites in both fertilizers and detergents. Fertilizers are used to establish plant growth. However, excess fertilizers applied can be carried off in runoff waters as a contaminant. Fertilizer management involves control of the rate, timing, and method of application. Management plans should have the ultimate goal of retaining nitrogen and phosphorous

from entering surface water runoff and nitrogen from entering groundwater. Detergents can contribute to water pollution if wash waters are released into the environment and carried by surface water runoff to a body of water either through the stormwater drain system or directly into tributaries adjacent to the development site as surface water runoff. Caution should be exercised to not over apply nutrients when establishing vegetation, limit the total area disturbed at any one time, and make repeat applications of nutrients as the plant grows. Hydro-seeding with a tackling substance can reduce runoff contamination concerns. Avoid excessive use of fertilizers and detergents on the site. Detergent-contaminated wash water should be contained on site and hauled similarly as is domestic waste.

Hazardous Materials and Wastes

Many of the materials found on at a construction site may be hazardous to the environment or to personnel. It is important to read all labels of the materials or products you have on site; they may contain warning information that will help you to become aware of a potential problem. The following list of substances (at a minimum) should be considered hazardous: 1) paints; 2) acids for cleaning masonry surfaces; 3) cleaning solvents; 4) chemical additives used for soil stabilization (palliative such as calcium chloride); and 5) concrete curing compounds and additives. Follow the instructions provided on material safety data sheets (MSDS) for proper handling and disposal of wastes.

Litter Control

Litter control involves the removal of litter from streets and other surfaces before runoff or wind moves these materials to surface waters. This practice will prevent litter from becoming potential pollutants as well as improve the aesthetics of the area. A major source of phosphorous in urban runoff is from the leaves and lawn clippings. Removing these materials before they enter surface waters can reduce phosphorous loadings significantly. Other litter considered in this practice includes pet wastes, trash, oil, and chemicals (pesticides and cleaners). Besides the nutrients being contributed, most of the materials are organic and create a high oxygen demand when they break down in the water body. Pet wastes also pose a significant threat to water quality by contributing bacteria and other potential parasitic pathogens harmful to human and animal contacts. Phosphorous levels can be reduced by as much as 30-40% just by implementing litter controls. To be most effective this practice requires community-wide involvement. Programs provided on a community-wide basis could include some or all of the following: leaves and grass clipping recycling; street cleaning on a regular basis; catch basin cleaning; garbage collection; and imposing pet waste management strategies. Most of these programs have an educational component attached to sensitize the public as a whole.

Natural Geologic Drainage

Natural geologic drainage can contain acid and alkaline solutions from exposed soil or rock formations high in acid or alkaline substances formed in the natural elements. Control of these potential pollutants involves good site planning and pre-construction geologic investigations. Plans to seal fractures in bedrock with grout and bentonite will

often reduce the amount of seepage. If the source of clean water entering the fractures can be determined and this water can be diverted, this may be the best practice available. Another method is to neutralize the seeping solution(s) before it leaves the site.

Pesticides

Pesticides include insecticides, rodenticides, fungicides, and herbicides which are often used on construction sites. Steps should be taken to reduce the risks of having to use pesticides, but when you must, handle the materials as infrequently as possible, observe labels for proper application rates, application methods, handling, storage, personnel safety, and disposing of unused portions and rinsed pesticide containers. Store pesticides in a locked, fire-proof, and dry area. Provide curbs or dikes to contain any accidental spill and have measures available to contain and cleanup spills

Petroleum Products

Oil, gasoline, lubricants, and asphaltic substances such as paving materials are considered petroleum products. These materials should be handled carefully to minimize their exposure to stormwater. Petroleum products usually occur where road construction is occurring, at vehicle storage areas, or areas where onsite fueling and equipment maintenance is performed. Contain and cleanup petroleum spills immediately. Prevention is the key to any spill or leak, therefore, prepare a containment area to capture leaks from storage containers. While refueling and changing lubricants, use a portable device or construction of a temporary earthen dike.

Sandblasting Grits

Sandblasting is a commonly used technique to remove paint, dirt, etc., from surfaces. Sand is sprayed on the surface to be cleaned. Sandblasting grits consist of both the spent sand and the particles of paint and dirt removed from the surface. Grits are considered a hazardous waste if they were used to remove paints from old structures where lead, cadmium, or chromium based paints were used. These materials should not be allowed to enter stormwater drains, sanitary sewers, or any other public water conveyance.

Sanitary/septic Disposal

Almost all construction sites have a sanitary facility for onsite personnel. The most common facility is a portable facility that stores human body wastes (domestic) and is periodically emptied by a permitted hauler and emptied at an approved sanitary sewage facility site. Domestic waste haulers will know when and where to haul and properly handle untreated (raw sewage) septage. Untreated sewage or septage should never be discharged or buried onsite.

Street Sweeping

Street sweeping involves the removal of grit, debris, and trash from urban impervious areas such as streets, parking lots, and sidewalks. This practice is applicable during the construction phase and upon completion of the development. Streets are normally swept with either a mechanical broom sweeper or a vacuum sweeper. If these materials are removed from the streets and gutters where they are deposited, they can not be swept into streams by stormwater runoff. In most cases this operation has been used for aesthetics,

however it has been shown that sediment, nutrient, and oxygen-demand substance loadings can be reduced significantly when surfaces are swept frequently. More modern efficient street sweepers, and more skillful equipment operators make this operation more appealing to achieving water quality benefits. Coarse pebbles, grit, leaves, trash, and other debris is most effective in the sweeping operation. Sweeping is most effective two times a year, early spring and late fall. During these times it is easier to capture de-icing chemicals and sanding grits applied during the winter season and leaves and other lawn clippings from the balance of the year.

Sump Pit

A sump pit is a temporary hole or pit placed so that it can collect water from sediment traps and basins or excavations. In the center of the pit is a standpipe with holes which is surrounded by stone. Water that collects in the pit flows through the gravel into the standpipe and is pumped out to a filtering device or, in some cases, directly to a receiving water. The sump pit discharge may be pumped directly to a receiving water only if the standpipe has been properly wrapped in filter fabric medium. The number and location of sump pits used in traps or basins will depend upon the specific site or any other state or local requirements.

Waste Disposal

Proper management and disposal of building materials and other construction site wastes is an important part of pollution prevention. Construction materials overlooked as potential sources of stormwater contamination include surplus or refuse building materials including hazardous wastes and materials. This practice does not provide specific details on how to handle or dispose of these materials. Consult the product label or supplier and your local, state and federal regulatory agencies for proper disposal procedures.

INSPECTIONS

Inspection is a process by which an evaluation of pollution prevention measures applied are still effective. In most cases, inspection of prevention measures requires an inspector to look at all disturbed areas and sediment control measures on site taking measurements of sediment accumulation (depending upon measures installed). Inspections are conducted on a regular schedule plus after every significant rainfall event causing surface water runoff. A regular inspection and maintenance program reduces the chance of contaminating stormwater by finding and correcting problems before the next runoff event. The inspector should determine whether or not the measure was installed or performed correctly; whether or not there has been damage to the measure since it was installed or performed; what should be done to correct any problems with the measures installed; and finally what measures will accomplish the same objectives for a failed prevention measure installed. The following areas are of importance when performing a site inspection: 1) seeded areas (permanent and temporary); 2) mulched areas; 3) areas stabilized with geotextiles; 4) sod stabilized areas; 5) silt fences and straw bale barriers; 6) earthen dikes; 7) brush barriers; 8) drainage swales (grassed waterways); 9) sediment traps and basins; 10) subsurface drains; 11) pipe slope drains; 12) level spreaders; 13) storm drain inlet protection measures; 14) rock dams and outlet protection; 15) reinforced

soil retaining systems; 16) diversion(s); 17) buffer zone(s); detention ponds and basins; 18) filter strips; 19) terraces; 20) impoundment structures; 21) infiltration devices; 22) bio-engineered slope protection; 23) stormwater wetlands; 24) streambank stabilization (vegetative and structural); 25) streambank setbacks; 26) vegetation preservation; 27) stream crossings; 28) tree and shrub plantings and protection; and 29) good housekeeping practices.

MAINTENANCE

Maintenance of pollution prevention measures involves the upkeep and repair of the installed measures to reduce stormwater contamination. Maintenance is important because the control measures implemented may be of little or no use if they have not been properly maintained or managed. Good maintenance helps to ensure that these measures are in proper working order when called upon during a runoff event or during a spill condition. Maintenance includes those procedures or techniques used to maintain good effective operating condition vegetation, erosion or sediment control measure, and other protective measures identified in the site plan. Maintenance should be performed either on a interval determined by the design professional or when the inspection report finds it necessary to be most effective. Most maintenance activities for erosion and sediment controls are fairly basic.

RECORDKEEPING

It is important to document the inspection and maintenance of the pollution prevention measures installed. These records can be used to request scheduling for maintenance and repair needed. It also can be used to prove to local and state agencies that the installed measures are adhering to the permit granted. Stormwater plan managers should request their consulting design professional develop and provide an inspection, maintenance, and recordkeeping process with record keeping forms to report observations and along with key features to monitor as requirements of the permit.

REFERENCES

- Storm Water Management for Construction Activities-Developing Pollution Prevention Plans and Best Management Practices, USEPA Office of Water (WH-547), EPA 832-R-92-005, 9/92
- Standards and Specifications, Section IV, Field Office Technical Guide (FOTG), USDA-NRCS-Missouri
- Protecting Water Quality - A Field Guide to Erosion, Sediment, and Storm Water Best Management Practices for Development Sites in Missouri, St. Charles SWCD and DNR-DGLS, 11/95
- Protecting Water Quality in Urban Areas-Best Management Practices in Minnesota, Minnesota Pollution Control Agency, Division of Water Quality, St. Paul, MN, 12/94
- Illinois Urban Manual; A Technical Manual Designed for Urban Ecosystem Protection and Enhancements, Illinois Environmental Protection Agency, Prepared by USDA-Natural Resources Conservation Service, 1995

FOOTNOTES

* PRACTICE TERMINOLOGY USED IN MISSOURI SWCD PUBLICATIONS

"MULCHING (484)" - USDA-NRCS-MISSOURI CONSERVATION PRACTICE TITLES AND CODES

RESOURCE EXTRACTION

SURFACE AND SUBSURFACE MINING

The state has active and abandoned surface mines for a number of commodities. The most important mines in terms of amount of surface areas affected are coal, limestone and barite. Other common surface mining is for clay, sand and gravel.

The state has many flooded abandoned underground mines. These are predominantly coal mines (from north central to southwest Missouri) and lead-zinc mines (St. Francois, Madison and Jasper Counties). In the Joplin area, the shallow bedrock aquifer has elevated levels of sulfate and several heavy metals due to mineralization of groundwater in flooded mines.

Water Quality Problems

The latest state assessment indicates a total of 156 miles of stream are adversely affected by mining activities, of which 128 miles are affected by abandoned lead-zinc mined lands and 26 miles by drainage from abandoned coal mined lands. Abandoned lead-zinc mines and their tailings continue to impact waters decades after mining has ceased. Missouri's Superfund Program is addressing some of these concerns. However, long-term impacts are expected to remain.

Regulatory Controls

Discharges from all areas, point or nonpoint, are required to meet the state's water quality standards found at 10 CSR 20-7.031. Facilities that have National Pollutant Discharge Elimination System [NPDES] permits must comply with permit limits instead of water quality standards.

All areas having a discrete discharge are considered point sources and must also comply with the state permit regulation 10 CSR 20-6.010 and with the state effluent regulations 10 CSR 20-7.015, including appropriate federal effluent standards and guidelines 40 CFR subchapter N. effluent standards and guidelines. Many areas previously considered nonpoint sources are now considered point sources and are being permitted per state stormwater controls guidance contained in 10 CSR 20-6.200. This includes areas where stormwater runoff is collected by man-made or natural conveyances and discharged at discrete locations.

Due to loss of state funding in 2003, Missouri no longer regulates coal mining as previously required by Chapter 10 CSR 40. However, Federal regulations are in effect at 30 CFR to regulate active surface coal mining. Surface coal mines must also comply with the performance standards of 30 CFR 816 and requirements for the protection of the hydrologic balance are given at rule 30 CFR 780.21 and 816.41. In-situ coal processing (solution mining, borehole mining, fluid recovery mining, etc.) must meet the performance standards of rule 30 CFR 828, which includes provisions for monitoring surface water and groundwater. Stability and maintenance of tailings dams greater than 35 ft. in height is controlled by state regulations 10 CSR 22-1.010 through 4.020 and Missouri State Statute Chapters 236.400 through 236.500. (See Table 13.)

Table 16
REGULATORY AUTHORITY/RESOURCE EXTRACTION

Agency/ Program	Statute or Regulations	Activity	Funding
DNR/LRP-AML	30 CFR	Identify and rank abandoned mined lands. Contract for reclamation according to established priority.	100% federal (tonnage fee on surface mined coal)
DNR/LRP-IM	RSMo 444.500 RSMo 444.760	Issue permits for mining of limestone, sand, gravel, barite, tar sands and clay.	Permit fee
DNR/LRP-SC	30 CFR 710 - 882	Regulate surface mining. (All runoff from a permit area is point source discharge requiring NDPES permit.) Extensive permitting and control. Frequent inspections at least 1/mo.	100% federal
DNR/WPCP-PS	10 CSR 20-6. 10 CSR 20-7. 40 CFR subchapter N	Permit to discharge, develop limits for discharge, monitor discharge and water quality standards.	Federal
DNR/WPCP-PS	40 CFR 122 10 CSR 20-6.010	Regulate stormwater runoff and storm generated pollutants.	Federal
DNR/GSP-EG	RSMo 259 10 CSR 50	Regulate brine injection recovery mining.	Federal
DNR/DRSP	RSMo 236.400-.500 10 CSR 22-1.010-4.020	Regulate stability and maintenance of tailings dams greater than 35 ft. in height.	Federal
DNR/WPCP/ PLANNING	10 CSR 20-6.060	Water quality certification of dredge and fill activities to waters of the United States, including wetlands.	100% State
USCOE	33 CFR Pts. 320-330	Regulate discharge of dredge and fill activities to the waters of the United States, including wetlands.	100% Federal

KEY

USCOE = U.S. Army Corps of Engineers
DNR = Department of Natural Resources
LRP = Land Reclamation Program
WPCP = Water Pollution Control Program
GSP = Geological Survey Program
DRSP = Dam & Reservoir Safety Program
AML = Abandoned Mined Lands
IM = Industrial Minerals

SC = Surface Coal
PS = Permits Section
EG = Economic Geology

Control Programs and Concerns

Active waste disposal from underground metallic mineral mining is adequately regulated via NPDES permits, dam safety regulations and the Metallic Minerals Waste Management Act. The Act also provides regulatory controls on tailings piles once mining and milling cease at presently active mines.

Abandoned tailings ponds are huge concentrations of fine, easily eroded ground rock contained by earthen/ground rock dams. If the dam face and water control and internal drainage structures are not maintained, the dam can fail. Excessive amounts of sediment washed into receiving streams can bury the stream bottom, degrading aquatic habitat and introducing lead and other heavy metals into the aquatic ecosystem.

Ongoing and generally successful programs regulate active coal mines and reclaim some abandoned mine lands. Recent changes in the Abandoned Mine Land Program have allowed the environmental benefits of reclamation to be given greater consideration when prioritizing projects for future construction funding.

The greatest area of concern is for abandoned non-coal mining areas where reclamation costs are typically very high and funding for this kind of work is difficult to obtain.

Erosion and subsurface flow through of mine tailings adversely affect many streams in the state. Reclamation of these areas involve earth moving, regrading the site, re-vegetation of treated mine spoils, diversion of surface waters around the site, and various forms of discharge structures and water treatments. The expense would commonly exceed the resources of the present landowners and there are few sources of funding available for this kind of work.

Table 17
BEST MANAGEMENT PRACTICES
EROSION, DEPOSITION OF SEDIMENT IN STREAMBEDS AND DISCHARGE OF METALS INTO RECEIVING WATERS

PRACTICES	ADVANTAGES	DISADVANTAGES
<u>Reduce Erosion</u> Artificial windbreaks.	Low maintenance costs.	High initial cost.
Tree windbreaks.	Low cost.	May be difficult or impossible to establish in some locations.
Establish vegetative cover.	Effective in reducing wind and water velocities across tailings.	May be difficult and expensive to establish vegetation. Periodic maintenance activities may be necessary to keep vegetation alive. (Irrigation, mulching, fertilization, liming).
Promote increased use of tailings.	Reduces the size of tailings areas.	Some tailings areas are so large, this practice would be inconsequential. Lead-zinc tailings contain small amounts of lead, an environmental toxicant.
Eliminate or reduce human activities on tailings.	Preserves other BMPs.	Tailings are often popular recreation areas.
Divert surface runoff away from stockpiles.	Decreases volume of water in contact with stockpiles.	Initial cost to install diversion structure.
Collect and settle all runoff water from stockpiles.	Reduces amount of solids and turbidity in runoff water discharges from the site.	Space limitations may make this impractical in some locations.

Table 17 cont.
BEST MANAGEMENT PRACTICES
EROSION, DEPOSITION OF SEDIMENT IN STREAMBEDS AND DISCHARGE OF METALS INTO RECEIVING WATERS

PRACTICES	ADVANTAGES	DISADVANTAGES
<u>Prevent Dam Failure</u> Perform annual dam safety inspection	Evaluate stability of dam and make recommendations for any rehabilitation work needed. (Required for all dams over 35' in height.)	Additional work load for DNR staff.
Perform regular maintenance, particularly of overflow structures and internal drains	Prevents improper or excessive water movement over the dam, which can cause erosion of the dam. Maintenance costs are much less than repair costs.	Some additional maintenance costs.
<u>Road Construction</u> Use existing roads whenever possible when drilling test holes.	Minimizes disturbance of soil and vegetation caused by construction of temporary roads.	Aesthetically unappealing drill sites are more likely to be seen by the public.
<u>Smelter Areas</u> Pave all areas around smelters, collect and treat all waters from these areas.	Reduces infiltration of contaminated waters and reduces discharge of untreated runoff.	Additional cost of paving and increasing size of treatment facilities to handle stormwater runoff.
Properly operate and maintain baghouse dust collection system.	Decreases stack emissions of metal particulates (Pb emissions regulated by DNR Air Pollution Control Program).	Some additional operation and maintenance cost.
Spray paved areas regularly. Collect runoff.	Collection and treatment of fugitive dust.	Some additional operation and maintenance costs.
Separate precipitation from process water and contaminated water.	Minimizes commingled water that requires collection, storage and treatment. Use of gutters and enclosures at some of the buildings and reduced dumping of ore in outside areas have possible application.	Some additional operation and maintenance costs.

Table 18
BEST MANAGEMENT PRACTICES
FLOW OF MINERALIZED AND ACIDIFIED SURFACE AND GROUND WATER INTO RECEIVING WATERS

PRACTICES	ADVANTAGES	DISADVANTAGES
Reduce surface water inflows by use of diversion structures and by plugging bore holes and mine shafts.	Reduces volume of water mineralized in the mines.	High costs of locating the many openings, especially in the tri-state area, and high construction costs for plugging openings and diverting flows. It is not known how important these sources are as recharge points for shallow ground waters.
Locate drinking water wells away from mines. (DNR-DGLS can provide technical assistance.)	Less mineralized drinking water.	Costs for new wells and piping from new well(s) to distribution system.
Treat major artesian flows.	Would reduce levels of metals in discharge.	High initial costs. High operational costs. Alleviates symptoms instead of source of the problem. Would treat only those flows that would be practical to collect.
Regrade to facilitate runoff and retard infiltration.	Reduces volume of water available for subsurface acidification.	May aggravate surface erosion problems. Initial costs can be high.
Surface apply agricultural lime on land to treat small acid seeps.	Neutralizes some subsurface acidity.	Generally none, but high applications may hurt soil fertility.
Collect and treat acid waters.	Initially much less costly than land reclamation.	Treats symptoms rather than cause of problem. Perpetual treatment becomes very expensive.
Deeply bury most mineralized fraction of spoil during active mining.	Reduces contact of mineralized spoil with infiltrating surface or shallow ground waters.	Cost of segregating spoils by quality may be high.

Table 18 cont.
BEST MANAGEMENT PRACTICES
FLOW OF MINERALIZED AND ACIDIFIED SURFACE AND GROUND WATER INTO RECEIVING WATERS

PRACTICES	ADVANTAGES	DISADVANTAGES
Compact surface soil.	Reduces infiltration of surface water.	May retard good vegetative cover thereby increasing erosion problems.
Tile or install other rapid subsurface drainage systems.	Intercepts infiltrating surface water and routes away from buried mineralized spoil.	High initial cost. May make site excessively dry and difficult to establish good vegetative cover.
Install artificial aquatards.	Intercepts and diverts laterally-moving ground waters away from buried spoil.	High initial cost.
Create marsh that puts an anaerobic layer between oxygen supply and acid materials. Plant cattails which reduce acidity.	Creates wildlife habitat, low initial cost.	

Table 19
BEST MANAGEMENT PRACTICES
IN-STREAM MINING ACTIVITIES

PRACTICES	ADVANTAGES	DISADVANTAGES
Restrict in-channel mining to exposed sand and gravel bars.	Reduces perturbation of aquatic benthos and turbidity.	Eliminates a portion of the total resource from use.
Create berms to divert flows away from active mining areas or pools created by mining.	Decreases turbidity and prevents excessive solar heating.	May not be practical for mining in small stream channels.

SAND AND GRAVEL MINING

Characterization

Sand and gravel mining is a common activity in Missouri's watersheds. The size of operations varies greatly from large-scale commercial sand and gravel removal to individuals removing gravel from their own land for their personal use. Estimating the extent and effect of sand and gravel mining in Missouri is difficult because of the variance in size of operations, the number of sand and gravel miners and mine sites, and the remoteness of many sites.

A common perception in Missouri is that gravel accumulates in Ozark streams, building up a supply that must be removed before it "chokes" the stream. This accumulation was thought to be due to post settlement land-use changes, including deforestation of the uplands from 1880 to 1920, open-range grazing, upland row-crop agriculture, riparian land-use changes, and seasonal burning. A recent research report by the U.S. Geological Society, "Erosion and Deposition at the Riffle-Pool Scale in Gravel-Bed Streams, Ozark Plateaus, Missouri and Arkansas, 1990-1995," has greatly elaborated upon the history and effects of land-use changes and determined that the issue is much more complex than previously thought. In fact, increased gravel loading is also due to increases in volume and velocity of water brought about by various land-use changes within the stream or watershed that de-stabilized stream banks. Studies also show that, within the last 70 years, some basins have experienced degradation, some experienced waves of accumulation and degradation, and some were stable. Sand and gravel mining can significantly degrade Missouri's water quality and aquatic habitat if not managed appropriately.

Federal and State Authorities

Several federal and state agencies are involved in water quality protection activities with respect to sand and gravel mining. To further complicate the matter, the court system has recently been called upon to review the regulatory authority of the U.S. Army Corps of Engineers over part of sand and gravel mine discharges. The result of this court review has significantly decreased federal regulatory control over many sand and gravel mining operations.

The U.S. Army Corps of Engineers regulates placing dredged or fill material in waters of the United States under Section 404 of the Clean Water Act and under Section 10 of the Rivers and Harbors Act of 1899. "Fill" is essentially any solid substance, such as gravel, dirt, or rock. Waters of the United States include essentially all lakes, rivers and streams, including intermittent or dry streambeds and wetlands. Sand and gravel operations within the Corps jurisdiction require what is referred to as a 404 permit to operate.

However, in June 1998, the Corps of Engineers lost a lawsuit levied by the American Mining Congress, which resulted in the nullification of the so-called Excavation or Tulloch Rule. Under the Excavation or Tulloch Rule, the incidental redeposit of materials as they were scooped from the streambed by sand and gravel mining equipment was regulated as a dredged and fill material. However, the court recently ruled that such a "redeposit" was not an added pollutant, and therefore this activity was no longer regulated under Section 404. Hence, sand and gravel mining activities are no longer regulated by the Corps of Engineers if they remove the material from "bucket to truck" and do not place or store any material between the ordinary high water marks of the stream.

If the Corps determines that a 404 permit is required for a sand and gravel mining operation, then Section 401 of the Clean Water Act requires that this permit be certified with management practices or be denied as appropriate to protect water quality. In Missouri, the Missouri Department of Natural Resources develops water quality based conditions as part of the 401 certification. These conditions become part of the 404 permit that is issued by the appropriate Corps of Engineers district.

The state and federal agencies that have a role in regulating or managing state resources have developed a general permit for sand and gravel mining. The permit is issued to regulated operations unless they are mining in an environmentally sensitive watershed such as the Eleven Point River, in which case an individual permit must be issued.

The 404 general permit regulates many practices that are detrimental to streams. It specifies buffer zones, prohibits removal below the elevation of the waterline and modifications to the watercourse, and requires revegetation and protection of disturbed areas. Seasonal restrictions protect some spawning areas. These practices, if followed, do much to preserve the stream resources.

The Missouri Department of Conservation (MDC) has a significant advisory role in sand and gravel mining and the development of management practices. Fisheries personnel review the 404/401 general permits issued and often advise where the general permit allows discretion, such as buffer zones. Fisheries personnel can help mining operators and landowners in locating sites where they can remove gravel with minimal impacts to the stream. MDC will also become involved if mining causes a fish kill or other pollution incident.

DNR's Land Reclamation Program (LRP) has regulatory authority over commercial surface mining operations, which would include removal of sand and gravel. Because of the change in regulatory authority, the Land Reclamation Program has assumed more authority over sand and gravel mining operations. Only commercial use is regulated. Authorities and personal use activities are exempt from Land Reclamation Regulations.

Under the Endangered Species Act, the U.S. Fish and Wildlife Service may provide comments on mining operations that may adversely affect rare and endangered species, or modify or destroy those species' designated critical habitat.

Section 402 of the Clean Water Act requires an NPDES (National Pollutant Discharge Elimination System) permit, which is administered through the Missouri State Operating Permit program. Under this permit, the Missouri Department of Natural Resources regulates the washing and screening of gravel as a point source or wastewater discharge. Storm water runoff from sand and gravel mining is also regulated under Section 402 because federal and state regulations identify the activity as a regulated activity under Major Group 14 of the Standard Industrial Classification Manual (SIC Code), Mining and Quarrying of Nonmetallic Minerals. Both kinds of discharges are covered under one general permit written by the Department of Natural Resources, MO-G50. This permit uses effluent limits for settleable solids and pH as its

primary control mechanism. About 70 sand and gravel operations in the state are under this permit.

Environmental Effects

Sand and gravel mining that takes place along streams can adversely affect the water quality in many ways. Disturbance in or near the streambed can increase the turbidity of the stream. Environmental effects of increased suspended solids or settleable solids in streams include increased turbidity, reduced light penetration, reduced prey capture for sight feeding predators, clogging of gills/filters of fish and aquatic invertebrates, reduced benthic habitat, additional downstream transfer of phosphorus and nitrogen nutrients in stream sediments and reduced spawning and juvenile fish survival.

Other water pollution problems that sand and gravel mining may cause are litter and abandoned equipment left in or near the water. Fuel and oil from use or storage of equipment may also enter the stream.

Changes to the stream morphology caused by sand and gravel removal generally lead to the most damaging effects to waters. Accelerated changes to the streambed and banks lead to further changes in direction of flow and velocity of water, which can cause headcutting, other streambank erosion, and increased deposition of solids downstream. Streambank erosion can cause vegetation to lose anchoring for its root system and fall into the stream. Mining may remove vegetation entirely. These actions further de-stabilize the stream and accelerate the process of stream degradation. Removal of vegetation and its shading capacity can raise water temperatures, which can also lower dissolved oxygen concentrations, making the survival of stream biota more tenuous.

Management Practices

Good management practices can greatly reduce the detrimental environmental effects of sand and gravel mining. Commonly accepted practices, which have been incorporated into the 404/401 General Permit, are listed below. These management practices also provide guidelines for gravel removal by individuals or operations that are not required to obtain permits.

Provision for undisturbed buffer zones between the water line and mining activities, between the bank vegetation and mining activities, and on the landward side of the bank is essential to maintain stream stability and water quality.

Excavation of material should not go below the elevation of the water at the time of removal.

Gravel washing or sorting should be conducted above the stream or riverbanks, and so that material will not wash back into the water during rainfall events.

Gravel should not be pushed up against the stream banks.

Vehicles and other equipment should be limited to removal sites and existing crossings. Where fording is necessary, streams should be crossed perpendicular to the channel.

Fuel, oil, other petroleum products, equipment and any solid waste associated with the mining operation should not be stored between the stream and riverbanks.

Excavation of sand or gravel deposits should be limited to unconsolidated areas that contain primarily smaller material and that is loosely packed and contains no woody perennial vegetation greater than one inch in diameter, measured at breast height.

Where water is flowing or would flow after rain, the channel should not be relocated, straightened, or otherwise modified.

Contractors and workers should be trained in the management practices necessary to protect the stream.

Future

The General Permit is intended to keep sand and gravel operations out of the water, and goes far in specifying the management practices needed to protect the stream. However, with the reduction of COE authority, these management practices are no longer required for sand and gravel operations unless they become part of the LRP permit. Again, this has resulted in a significant loss of regulatory control and it appears that sand and gravel operations now pose a much greater threat to the quality of Missouri's streams.

An educational effort could enhance the effectiveness of sand and gravel management. Many state and federal entities are involved in managing sand and gravel activities. The number of agencies and their respective jurisdictions, requirements, and responsibilities are confusing to those not involved in day-to-day governance. Although the 404/401 General Permit goes a long way in combining and specifying many regulatory requirements, sand and gravel operators, even if still regulated, still may not be well informed about appropriate mining methods and requirements. Missouri's Land Reclamation Program has developed guidelines and an information network to assist the mining industry in their efforts to mine in an environmentally safe manner. The Missouri Department of Natural Resources also provides industry assistance through their Outreach and Assistance Program.

STOWAGE AND LAND DISPOSAL OF WASTES

BOAT SEWAGE

Congress passed the Clean Vessel Act (Public Law 102-587, subtitle F) in 1992 to help reduce pollution from vessel sewage discharges. All recreational boats with installed toilet facilities must have an operable marine sanitation device (MSD) on board. When operating a vessel on a body of water where the discharge of treated or untreated sewage is prohibited; the operator must secure the device in a manner, which prevents any discharge. In Missouri, all waters of the state, with the exception of Bull Shoals Lake and the Mississippi and Missouri Rivers are listed as no discharge zones (NDZ).

Marine Sanitation Device

Federal Law prohibits the discharge of untreated sewage from vessels within all navigable waters of the U.S. There are three types of sewage treatment devices allowed for marine sanitation.

Type I and II treat the effluent, while Type III holds the effluent until it can be pumped out, at a marina pump out station. Type I Flow-through device is suitable for vessels equal to or less than 65 feet in length. The effluent produced must not have a fecal coliform bacteria count greater than 1000 per 100 milliliters and have no visible floating solids. Type II Flow-through device is for vessels greater than 65 feet in length. The effluent produced by Type II must not have a fecal coliform bacteria count greater than 200 per 100 milliliters, and suspended solids not greater than 150 milligrams per liter. Type III – Holding Tank is used on vessels of any length. Boaters with Type III MSS can use any of the pump out facilities located throughout the state.

No Discharge Zones

A No Discharge Zone, is a designated body of water in which the discharge of ALL boat sewage, treated or untreated is prohibited. Boats equipped with Type I or Type II MSDs traveling in NDZ waters must secure the device in a manner that prevents any discharge. Missouri requires Y-valves to be locked in all state jurisdiction water, and prohibits Y-valve through hull discharge NDZ waters.

Enforcement of NDZ

The U.S. Coast Guard and the State in which the No Discharge Zone has been designated have enforcement authority of the NDA for vessel sewage. Penalties for misuses or failure to use MSD as well as illegal dumping of MSD in Missouri is \$1000 fine or up to 1 year imprisonment.

DOMESTIC SLUDGE LAND APPLICATION

Characterization

Sewage sludge is the inevitable end product of domestic wastewater treatment. Many of the organic solids, toxic organic chemicals, and inorganic chemicals are removed from wastewater and concentrated in the sludge. An estimated 250,000 dry tons of sludge are generated in Missouri from wastewater treatment plants. Of this total, about 60 percent of the sludge is incinerated, 30 percent is applied onto agricultural land, 7 percent is in sludge holding lagoons

and the remaining 3 percent is hauled to landfills. Land application of sludge for beneficial use is the preferred utilization method.

Land application of municipal wastes in Missouri is practiced for its beneficial effects on soils and crops and for the purpose of using the soil's physical, biological and chemical capabilities to degrade the waste products. However, before this material can be spread on the land, the material has to meet both federal and state standards governing the use and disposal of domestic wastes.

The name "biosolids," a term coined by the Water Environment Federation, has been adopted to apply to domestic sludge that meets treatment process criteria for both pathogens and metal pollutant limitations for beneficial reuse. The term was developed to identify sludges that are treated and managed for beneficial reuse and to promote wider acceptance of the product.

Although biosolids are suitable for use as agricultural fertilizers or soil conditioners when current standards are followed, most Missouri biosolids generators still approach biosolids as a disposal problem rather than as a marketable resource. Based on previous annual biosolids reports, improper sludge management practices are still widespread, despite the existence of land application guidelines. It should be mentioned however that the number of generators mishandling biosolids is decreasing, due primarily to more awareness of the biosolids standards.

Many public and private facilities do not have adequate storage for inclement weather conditions, thus biosolids are land applied at inappropriate times when contaminants such as bacteria, heavy metals and various forms of nitrogen compounds are likely to be washed into streams during storm water runoff or snow melt. In areas of karst topography and highly permeable soils, improper biosolids application may cause groundwater contamination due to translocation of excess nitrogen and disease-causing organisms.

Public acceptance of biosolids in Missouri is generally favorable, as evidenced by a long history of biosolids land application onto cropland. Prior to 1979, there were no specific state guidelines on sludge use and disposal. In 1979, state rules under Chapter 8.170, Sludge Handling and Disposal, established a general framework for sludge use and disposal. The general framework led to the development of state standards and guidelines for sludge disposal. These were published in 1982 in a DNR report, "Agricultural Use of Municipal Wastewater: A Planning Guide." The publication was revised in 1985 to include similar limits for metals as those later published in 1993 in 40 CFR Part 503 sludge rule. This planning guide was discontinued in 1993 and replaced by NPDES Permit Standard Condition Part III and University of Missouri Water Quality Guide publications WQ 420 through WQ 449.

<http://muextension.missouri.edu/explore/envqual/wq0420.htm>

Potential NPS Pollution Impacts

Storm water runoff flowing over fields that have received biosolids is a potential source of nonpoint source pollution. The impact of storm water runoff on surface water resources can be minimized if best management practices are followed. The applicable BMPs are covered in University Publication WQ 426, and these include restricted use clause, harvest deferment,

nitrogen and phosphorus loading, set back distances, site restrictions due to soil and weather conditions.

The primary objectives of land application best management practices are to prevent the movement of pollutants, maximize the rate of biodegradation in the soil, and maintain the land's potential for future use. The amounts of plant nutrients, particularly nitrogen and phosphorus and the types of pollutants that can be applied per acre, or whole sludge application rate, are critical factors in land application. To avoid overloading soils, sludge or biosolids application rates should be carefully determined prior to initiating land application.

Regulatory Authority

Sewage sludge is considered a water contaminant under both the federal Clean Water Act and the Missouri Clean Water Law. It is recognized as potentially harmful because it contains chemical pollutants and pathogens that may impact both human health and the environment.

In 1993, the EPA under the directive of the federal Clean Water Act, promulgated standards for use or disposal of sewage sludge, 40 CFR Part 503, also known as the sludge rule. This rule defines acceptable management practices and provides specific numeric limits for selected chemical and pollutants and pathogens applicable to land application of sewage sludge. The sludge rule is self implementing and directly enforceable by the EPA. The sludge standards are included in all NPDES operating permits issued to POTWs or other domestic treatment works.

The Missouri Clean Water Law regulates sewage sludge land disposal under Chapter 644 RSMo and 10 CSR 20 chapters 6,7 and 8. The current Missouri biosolids management program operates under the state permit rules and the delegated NPDES permit program for wastewater treatment facilities. Missouri incorporated Part 503 standards by reference into our state regulation under 10 CSR 20-7.015 (9) (F), which became effective May 9, 1994. However, the state is not delegated to run the federal sludge program, so EPA currently handles enforcement of 503 rules and the state addresses only water quality related violations.

In order to implement both federal and state sludge standards, the Missouri Department of Natural Resources and the University of Missouri Cooperative Extension Services developed a set of user friendly guidance documents to assist the permittees. These standards are designed to protect human and animal health and the environment by promoting safe use or disposal of biosolids. The Standard Conditions Part III for NPDES permits incorporates the University Extension water quality guidance documents by reference. The following water quality guides are issued with NPDES permits:

WQ 422 Land Application of Septage

<http://muextension.missouri.edu/explore/envqual/wq0422.htm>

WQ 423 Monitoring Requirements for Biosolids Land Application

<http://muextension.missouri.edu/explore/envqual/wq0423.htm>

WQ 424 Biosolids Standards for Pathogens and Vectors

<http://muextension.missouri.edu/explore/envqual/wq0424.htm>

WQ 425 Biosolids Standards for metals and Other Trace Substances
<http://muextension.missouri.edu/explore/envqual/wq0425.htm>

WQ 426 Best Management Practices for Biosolids Land Application
<http://muextension.missouri.edu/explore/envqual/wq0426.htm>

INDUSTRIAL SLUDGE AND WASTEWATER LAND APPLICATION

Characterization

This section addresses land application of industrial wastes under the Missouri Clean Water Law and regulations. Concentrated animal feeding operations are a sub-category of industrial wastes but are covered separately under the agricultural-livestock section of this document. “Land Application” does not include land disposal activities covered under the Missouri Solid Waste Management Law or the Missouri Hazardous Waste Management Law.

The definition of industrial waste sources under the Missouri Clean Water Law includes all facilities that are not domestic wastes. Domestic waste means sewage originating primarily from human sanitary conveniences and includes both publicly owned treatment works (POTW) and private domestic wastewater from residential and commercial sources.

Industrial land application facilities may include treated wastewater, wastewater sludges, biosolids or other residuals. Industries may land apply part or all of their waste materials depending on waste characteristics, regulatory requirements, permittee desires and site-specific factors. For example, an industry that is connected to city sewers will likely need to provide pretreatment of the wastewater prior to sending to the city, thus producing a pretreatment sludge that must be disposed by land application or other methods.

Industrial wastewater treatment facilities are required to meet the state effluent limitations in 10 CSR 20-7.015(9)(G). This rule requires use of the applicable pollutant control technology currently effective as published by EPA in 40 CFR 405-471. If there are no EPA standards available or applicable, the rule requires the department to set specific parameter limitations in proposed operating permits using “best professional judgement” (BPJ). The BPJ process establishes limits that will comply with Water Quality Standards for surface and subsurface waters under 10 CSR 20-7.031. In certain environmental settings, a higher level of wastewater treatment beyond EPA standards is required to protect especially sensitive water resources such as losing stream settings, karst topography, recreational streams, wild and scenic rivers, and other high quality or pristine areas. Land application is one of the preferred options in these sensitive areas because irrigation can provide treatment and reuse of wastewater that can achieve tertiary treatment or better depending on the specific irrigation design.

Land application may include one or a combination of the following:

- a) Consumptive water uptake by plants;
- b) Agronomic rates for utilization of nutrients and trace elements by growing plants; or
- c) Land treatment based on utilization/treatment/immobilization/attenuation factors for soil-plant system.

The type of land application system and acceptable land application rates depend upon many site-specific factors. The most common land application system in Missouri is the “no-discharge” system which provides complete storage of wastes for winter and inclement weather conditions and land applies the wastewater and/or sludges during the growing season at agronomic application rates for utilization in production of agriculture or timber crops (combination of options a and b, above). When designed and operated properly the “no-discharge” system will have releases only due to chronic storm events exceeding the 1-in-10 year annual precipitation or catastrophic events exceeding the 25-year, 24-hour rainfall event. Therefore, no-discharge does not equal zero discharge during these extreme rainfall events.

Potential NPS Pollution Impacts

Stormwater runoff flowing from land application fields and wastewater percolation into groundwater are potential sources of nonpoint source pollution. For a properly operated facility, nonpoint source impacts would be similar to other comparable agricultural fields. In contrast, poor operation and maintenance will result in significant discharges of pollutants due to over-application, spills, bypassing or other operation problems. Pollutants of concern are potential disease-causing organisms, nitrates, ammonia, phosphorus, boron, chlorides, sodium, NPDES priority pollutants and any other potentially toxic chemicals used at the industrial facility.

The proper design and operation of the pretreatment, storage and irrigation components minimize these potential impacts. Pretreatment of industrial wastes is required to reduce pollutants to acceptable levels prior to land application. Best Management Practices are established under state rules at 10 CSR 20-8.020, Section (15). Additional management practices to address site-specific factors must be addressed in the engineering report and operation plan required by 10 CSR 20-8.020, Section (3). Critical factors for land application are soil characteristics, soil depth, depth to groundwater, geologic conditions, topography, erosion control, vegetation management, nutrient loadings, hydraulic loading rate and concentration and loading rates for other pollutants. Although, the land application system is a relatively simple operating system, it will not operate itself. Proper operation, maintenance and monitoring of the land application system must be provided on a continuing basis to achieve the desired environmental protection.

Regulatory Authority

Industrial land application systems must be permitted under the Missouri Clean Water Law and regulations unless specifically exempted in 10 CSR 20-6.015(3). Permitting requirements are under 10 CSR 20 Chapter 6 and include both construction permits and operating permits. Operating permits must be renewed at least every five years.

Permits rules require all applicants to submit an engineering report that evaluates the environmental and economic feasibility of no-discharge type facilities such as land application, recycling and reuse or other no-discharge options. The final decision on discharge versus no-discharge is left up to the permittee except for facilities located in certain sensitive watersheds identified in 10 CSR 20 Chapter 7, Effluent Regulations. When, the facility is located within 2 miles of a losing stream or other special stream categories, no-discharge is mandatory and new discharges are not allowed except where there are no other feasible options based on the criteria outlined in the Chapter 7 regulations.

No-discharge permitting requirements are under 10 CSR 20-6.015. Land application sites for certain industries must also comply with the storm water discharge regulations in 10 CSR 20-6.200. The permit application must include an engineering report, plans and specifications, geologic report, environmental assessment and an operating plan in accordance with 10 CSR 20-8.020 and 10 CSR 20-8.220. The application must address compliance with effluent limitations and water quality standards under 10 CSR 20-7.015 and 7.031 for both surface and subsurface waters.

The design regulations under 10 CSR 20-8.020, Section (15) require wastewater to be treated prior to land application and outlines other land application restrictions. Paragraph (3)(D) of 10 CSR 20-8.020, requires an environmental assessment as follows: “The engineering report shall contain a detailed waste description, laboratory analyses and documentation of the treatability and potential environmental pathways for each constituent that may be present in the waste and wastewater.” Any waste that is classified as a “hazardous waste” pursuant to 10 CSR 25 must comply with the hazardous waste regulations under 10 CSR 25 and can not be land applied under 10 CSR 20 rules.

Operating permits include limitations and monitoring requirements, operation records and reporting requirements, best management practices and other special conditions. Storm water monitoring and groundwater monitoring is required where deemed appropriate. Monitoring reports must be submitted monthly, quarterly or annually depending on the size, complexity and location of the irrigation systems. Primary emphasis of the operating permit is to verify that the land application is being operated according to the approved plan and that water quality protection is maintained.

New permit application forms, “Form I” for wastewater and “Form R” for sludge/residuals, were first developed in October 1998 to specifically address land application facilities. These forms supplement other existing permit application forms. The Forms I and R contain a detailed list of supporting documentation needed to address the regulatory requirements and summarize the planned land application loading rates and operation and maintenance plans. The forms contain a detailed listing of testing requirements to characterize wastes and soils, and also include reference to other pertinent technical publications on toxicity and land application design parameters that must be addressed.

For additional reference information on land application, refer to the Proceedings of the Industrial Wastewater/Sludge Workshop, May 1997, University of Missouri-Columbia Extension Office. <http://muextension.missouri.edu/explore/envqual/wq0427.htm>

DOMESTIC WASTEWATER IRRIGATION

Characterization

Domestic wastewater means sewage originating primarily from human sanitary conveniences and includes both public owned treatment works (POTW) and private domestic wastewater from residential and commercial sources.

Conventional domestic wastewater treatment facilities are required to meet secondary treatment limits prior to discharge into state waters. In certain environmental settings, a higher level of wastewater treatment is required to protect especially sensitive water resources such as losing stream settings, karst topography, recreational streams, wild and scenic river ways, and other high quality or pristine areas. Wastewater irrigation is one of the preferred options in these sensitive areas because irrigation can provide treatment and reuse of wastewater that can achieve tertiary treatment or better depending on the specific irrigation design.

Wastewater may be land applied for either; a) consumptive water uptake by plants; b) for treatment and/or utilization of nutrients and trace elements onto vegetated land; or c) for land treatment/disposal. The type of irrigation system and acceptable land application rates depend upon many site-specific factors. The most common wastewater irrigation system in Missouri is the “no-discharge” system which provides complete storage of wastewater for winter and inclement weather conditions and land applies the wastewater during the growing season at application rates ranging from 12 to 24 inches/acre/year. At these low rates, the vegetation will uptake almost all of the applied wastewater if application rates are scheduled during periods when additional soil moisture can be utilized by growing vegetation. At higher application rates, the irrigation system provides a combination of water consumption, nutrient uptake and soil treatment of the applied wastewater.

Several hundred domestic wastewater irrigation systems are operating in Missouri. The oldest date back to the earlier 1970's. Two of the nations oldest wastewater irrigation systems are the cropland irrigation system at the City of Vandalia and the forest irrigation system at Bennett Spring State Park. Both have operated for over 25 years without problems.

Potential NPS Pollution Impacts

Stormwater runoff flowing from land application fields and wastewater percolation into groundwater are potential sources of nonpoint source pollution. Primary pollutants of concern are potential disease causing organisms, nitrates, ammonia, phosphorus, boron, chlorides and sodium. Other NPDES priority pollutants may be of concern for certain municipal systems with significant industrial sources. Pretreatment of industrial wastes is required to reduce pollutants to acceptable levels in the irrigation water.

The proper design and operation of the pretreatment, storage and irrigation components minimize these potential impacts. Best management practices are established under state rules at 10 CSR 20-8.020, Section (15). Additional management practices to address site-specific factors must be addressed in the engineering report and operation plan required by 10 CSR 20-8.020, Section (3). Critical factors for land application are soil characteristics, soil depth, depth to groundwater, geologic conditions, topography, erosion control, vegetation management, nutrient loadings, hydraulic loading rate and concentration and loading rates for other pollutants.

Regulatory Authority

All wastewater irrigation systems with flows exceeding 3000 gallons per day must be permitted under the Missouri Clean Water Law and regulations. Permitting requirements are under 10 CSR 20 Chapter 6. No-discharge permitting requirements are under 10 CSR 20-6.015. The permit application must contain engineering report, plans and specifications and operating plan in accordance with 10 CSR 20-8.020 and 10 CSR 20-8.220. Permitting requirements include limitations and monitoring requirements, operation records and reporting requirements, best management practices and other special conditions. Stormwater monitoring and groundwater monitoring may also be required where deemed appropriate. Monitoring reports must be submitted monthly, quarterly or annually depending on the size, complexity and location of the irrigation systems.

The design regulations under 10 CSR 20-8.020, Section (15) require wastewater to be treated prior to irrigation by a treatment process such as a wastewater treatment/storage lagoon or equivalent treatment system. Pretreatment must also be provided as necessary to meet the acceptable pollutant concentrations in the irrigation water. Pollutant criteria for irrigation water are provided in the EPA Process Design Manual on Land Treatment of Municipal Wastewater, publication number EPA-625/1-81-013, U.S. EPA, October 1981. A list of the key parameters for irrigation are contained in Table 4-5 “Suggested Maximum Applications Of Trace Elements To Soils Without Further Investigations,” and Table 4-16 “Summary of Wastewater Constituents Having Potential Adverse Effects On Crops.”

ON-SITE WASTEWATER DISPOSAL SYSTEMS

Missouri has widely differing geologic configurations and population densities. Karst formations and permeable soils of the Ozarks create a potential for groundwater contamination from on-site wastewater systems, a threat magnified by a rapidly growing population and increasing development. Additionally, much of this area has a shallow depth of soil to bedrock and sharp downgradients. The three fastest growing counties in the state during the 1990’s are located in this area, with a majority of the land area not covered by sewer districts.

On the other hand, the tight clay soils of northern Missouri offer little absorption of moisture, greatly increasing the possibility that inadequately treated or untreated wastes will find their way into the lakes and streams of the state, or become ponded where incidental human contact may occur.

Regulatory Authority

The Missouri Department of Health and Senior Services (MDHSS) maintains statutory authority over on-site disposal systems under Sections 701.025 through 701.059 RSMo and implemented by 10 CSR 20-3.060, Minimum Construction Standards for On-Site Sewage Disposal Systems, and 19 CSR 20-3.070, Fees Charged by Department of Health for Inspection of Existing On-Site Sewage Disposal System Requested by a Lending Institution; and 19 CSR 20.3080, Description of Persons Qualified to Perform Percolation Tests or Soils Morphology Examinations in Determining Soil Properties for On-site Sewage Disposal Systems. Sewage treatment facilities that have a designed maximum daily flow or an actual maximum daily flow of three thousand

gallons or less fall under these sections. Single family residence lots of more than three acres are exempted. Systems with greater than three thousand gallons per day outfall and multiple lot systems that discharge are under jurisdiction of the Department of Natural Resources.

Section 701.038 RSMo limits complaint investigation to instances of communicable disease investigation and complaints by an aggrieved party or adjacent landowner. Section 701.040 requires MDHSS to develop a state standard for location, size of sewage tanks and length of lateral lines based on percolation or permeability rates of the soil, construction, installation and operation of on-site sewage disposal systems. The statute goes on to set requirements for inspections, permits, system modification or major repairs and contractor registration, and directs fees be collected.

With the aforementioned three-acre exception, anyone installing new on-site sewage systems or making major repair to an existing on-site sewage system must obtain a permit from MDHSS. Information must be provided on an application indicating the soil and site conditions, systems design, and setback distances. All factors must be acceptable to minimum construction standards before a permit will be issued. Law provides penalties for installation of systems without required permits.

The statutory and regulatory authority that exists is divided between the Missouri Departments of Health, Section for Environmental Public Health; and Natural Resources, Water Pollution Control Program. Authority of the Department of Natural Resources is in Chapter 644, RSMo, and 10 CSR 20, 1 through 9, and that of the MDHSS is RSMo 701.025 - 701.059, and 19 CSR 20-3.060, 070 and 080. A joint memorandum of June 18, 1996 delineated the areas of responsibility and cooperation between the two agencies (see Attachment A). Regulations for the design of small sewage works and standards for individual sewage treatment systems have been developed by DNR and are proposed rules (10 CSR 20-8.020, Design of Small Sewage Works, and 10 CSR 20-8.021, Individual Sewage Treatment Systems Standards).

Potential NPS Impacts

On-site sewage disposal is a necessity in much of the state with an estimated 500,000 subsurface disposal units in place, an unknown number of lagoons, and approximately seven to twelve thousand new systems being installed each year (MDHSS). The state law governing on-site sewage disposal has been greatly amended and there has been a corresponding dramatic increase in the number of local on-site sewage ordinances. As the new law becomes better known to installers and the public, and as local and state agencies become better equipped to manage the workload, installation of new systems and repair of existing systems should reduce the negative impact upon the public health and environment. However, absent actionable complaints, existing systems are grandfathered regardless of whether they are functioning properly. In addition, the law exempts many single-family residences with lots consisting of three acres or more from minimum construction standards. Therefore, malfunctioning existing systems, illegally installed new systems, and legally installed but inadequate systems can present the following problems in creating a threat to surface or groundwater.

1. Installation of an unsuitable system for a particular location. For example, an absorption field placed in the vicinity of sinkholes could allow septic system effluent a direct access to groundwater.
2. Installation of an otherwise appropriate system (for the area) on an improper site, i.e., an absorption field located in close proximity to a water well, possibly providing direct access to groundwater and the drinking water supply.
3. Under sizing of a disposal system caused either by faulty design before construction or by a change in usage after construction, resulting in inadequate treatment and/or discharge, potentially to waterbodies.
4. Installation of any type on-site disposal system in areas where soils, geology or lot size are prohibitive. Results are the same as 3.
5. Use of inappropriate materials or poor workmanship during construction. (Same as 3.)
6. Lack of adequate maintenance of an appropriate system, i.e., no schedule of routine pumping of septic tank sludge. (Same as 3.)

Best Management Practices

Use of best management practices could contribute to a decrease in water quality problems caused by on-site wastewater systems.

1. Have the proposed site evaluated by a knowledgeable person using information from soil morphology or percolation tests and other relevant data.
2. Locate the system at the best possible site on the lot. Besides following the recommendations outlined in #1 above, do not install drainage fields upgradient from major karst features, domestic wells or surface water.
3. Submit an application for a permit, if required, to MDHSS or DNR and obtain the necessary permit(s).
4. Follow construction standards for the recommended system. Use appropriate materials and correct installation techniques.
5. Use the system as originally designed. Don't overload by practicing water conservation.
6. Maintain the system appropriately.
7. Consider the use of advanced on-site systems other than the traditional septic tank/drainage field or lagoon when the system has to be installed in areas where depth to bedrock is shallow, karst features are identified or the drainage field will be upgradient to domestic wells or surface water.

Systems primarily used in Missouri are the septic tank followed by absorption field and the facultative lagoon. However, as not all soils will allow conventional septic tank/absorption field installation, alternative systems should be considered. Depending on soil and site conditions, alternatives would be:

1. Mound system
2. Low pressure system
3. Sand filter
4. Drip irrigation
5. Gravelless absorption field
6. Wetland
7. Land application
8. Water conservation
9. Separation of gray water
10. Holding tank
11. Peat Moss Bio-filter
12. Other site specific innovative systems

Text reproductions of the original letters.

This MOA was updated in Dec. 2003, but was unavailable during latest revision.

MEMORANDUM

DATE: June 18, 1996

TO: DEQ Regional Directors
DEQ Water Pollution Control Program Staff
DEQ Technical Assistance Program
DGLS Environmental Geology Program
DOH District Environmental Sanitation Supervisors
Local Health Agencies and other Agencies
Administering Sewage Programs

FROM: John A. Young, Director
Division of Environmental Quality
Department of Natural Resources

Pamela Rice Walker, Director
Division of Environmental Health & Epidemiology
Department of Health

SUBJECT: DNR – DOH Jurisdiction and Cooperation with
Sewage Problems

Over the years, there have been occasions when it was not clear which agency was responsible for particular sewage systems. In particular, DNR's or DOH's policies and procedures regarding septic tank requirements have been confusing. The passage of Senate Bill 446 (which amended the law for small on-site sewage systems) accentuates the need for distinguishing agency jurisdiction. The following table provides a division of responsibility for review and permitting:

RESPONSIBLE AGENCY FOR REVIEW AND APPROVAL

	<u>DOH</u>	<u>DNR</u>
1. FOR A SINGLE FAMILY RESIDENCE <3000 GPD	X	
2. FOR OTHER SOURCES OF DOMESTIC SEWAGE FLOWS <3000 GPD, INCLUDING MULTIFAMILY, COMMERCIAL, AND RESTAURANTS WHICH DISCHARGE INTO SUBSURFACE SOIL ABSORPTION SYSTEMS OR HOLDING TANKS ²	X	
3. FOR INDUSTRIES, WHICH INCLUDES WASTES NOT DEFINED AS DOMESTIC SEWAGE ³		X
4. FOR OTHER SOURCES OF DOMESTIC SEWAGE FLOWS <3000 GPD, INCLUDING MULTIFAMILY, COMMERCIAL, AND RESTAURANTS THAT DO NOT DISCHARGE INTO SUBSURFACE SOIL ABSORPTION SYSTEM (e.g., discharge to lagoons)		X
5. FOR ANY SOURCE WITH A FLOW THAT IS >3000 GPD		X
6. FOR APPROVAL OF WASTEWATER TREATMENT IN SUBDIVISIONS > 15 LOTS ⁴ (3-14 lots not now regulated)		X
<ol style="list-style-type: none"> 1. Includes day cares licensed for up to 10 children that produce domestic sewage and does not change the overall predominant use of the structure as a single-family residence. 2. Calculations of GPD for on-site systems will be made according to the DOH rule. 3. Domestic sewage is defined in 701.025.(12) as: "...human excreta and wastewater, including bath and toilet waste, residential laundry waste, residential kitchen waste and other similar waste from household or establishment appurtenances..." 4. DNR's regulation defines a subdivision as 15 lots, however, subdivisions are now defined in RSMo. Chapter 701.025 as 3 lots. (Outside of the definition given in this statute, the new law does not mention the word "subdivision" again.) DNR will be working to amend its rule to make it consistent with state law within the resources available. The matter of obtaining resources to address the additional numbers of subdivisions between 3 and 14 lots is staggering. DOH personnel are requested to be patient and understanding of the time it may take for DNR personnel to respond to the workload. DOH personnel should be very aware that it may be more than a year before DNR has completed the administrative rules process to revise its subdivision regulations. 		

The appropriate DNR regional office to obtain the proper permits. Residential, food service establishments, lodging rule for on-site sewage systems directs developers of subdivisions to first contact DNR before going to DOH for an application for a permit. The intent is to route all regulated subdivisions through DNR to determine whether central sewers are required. If DNR determines central sewers are not required, the individual on-site systems will be reviewed and permitted by DOH personnel. Communication between the respective DNR and DOH offices is essential.

DNR does not review and permit on-site installations for individual residences in a subdivision. DNR uses generalized screening criteria to determine if centralized sewage collection and treatment is required or if on-site systems may be used in a subdivision. DNR regulates the developer of the subdivision and not the individual lot owner. If an engineer's report is required to make this determination, DNR will require soils information and generic designs of on-site systems to be used in the subdivision. (The generic designs are intended as an example of the on-site systems that will be used and should not be construed as a mandatory requirement for any particular lot.) Please be aware that an engineer's report is not mandatory in small subdivisions with fewer than 50 lots. The small subdivisions may only have a favorable geological evaluation for approval to use on-site systems.

Until DNR revises the subdivision regulations, 10 CSR 20-8.021 will be used for review of the engineer's reports. DNR intends to revise the subdivision regulations so that environmental considerations and the practicality of using on-site systems in a subdivision will be the focus of the rules. Design criteria, that may be referenced in the subdivision regulations, would be based upon 19 CSR 20-3.060. During revision of the subdivision regulations, DNR will greatly appreciate any and all input as to locations where subdivisions should have central sewers and where on-site systems are safe for the environment and public health. The basic premise that DNR will be working under is that if sewers are needed in a subdivision, they should be constructed before any lots are sold or houses constructed.

According to the state's Clean Water Law, RSMo. Chapter 644, it is unlawful for any person to build, alter, replace, operate, use or maintain any water contaminant or point source in this state that is subject to permit from DNR. Exceptions to obtaining permits from DNR are as follows:

1. A system that serves a single-family residence. Such may include an in-house business such as a day care licensed for up to 10 children or a beauty shop, provided the additional wastewater is domestic and 50% or less of the total design flow. (Please note that the intent of the subdivision regulations is to maintain wastewater on the property of origin.)
2. A system that receives 3000 GPD or less of domestic sewage and discharges into a soil absorption system.
3. Certain "no-discharge" systems utilizing sealed lagoons with storage and disposal by land application. These systems may not require permits, however, they are still subject to DNR regulations, review and approval to insure they are in fact "no discharge."

All other surface discharge systems whether or not the design flow is less than 3000 GPD must have a construction permit from DNR. Commercial systems with flows less than 3000 GPD that handle only domestic sewage do not need to be routed through DNR if the wastewater will be disposed of into a soil absorption system that complies with DOH's state standard. If an applicant proposes to discharge into a soil absorption system that does not comply with the DOH standard or otherwise would surface and discharge, please refer him/her to the

appropriate DNR regional office to obtain the proper permits. Residential, food service establishments, lodging establishments and office buildings are all considered to produce domestic type sewage. Most manufacturing plants, and places where petroleum products and solvents are routinely handled, e.g., service stations, are considered potential sources of industrial wastes and should be routed through DNR for a determination of permit authority.

Revisions to amend the portions of the DOH rule that allowed discharge are being drafted cooperatively by our staffs to provide better assurance the Clean Water Law will not be violated. (Originally, DOH thought that allowing discharges from sand filters and wetlands would provide better effluent quality than with lagoons. However, potential conflict with the Clean Water Law makes it necessary for DOH to amend this portion of their rules.)

Variances will be allowed for some existing malfunctioning systems that serve single family residences. Whenever effluent can be realistically contained in a soil absorption system, that should be required. However, there will be cases where, due to small lot size, poor soils, and other restrictive features, it will be difficult or cost prohibitive to maintain the effluent in the soil, much less contain it on the property. In these cases, upgraded pretreatment and as much soil absorption as possible shall be used to produce the highest quality effluent possible before any portion of the effluent is discharged or leaves the property. This is not a complete solution, but may be the best possible response given certain locations' restrictive conditions. This paragraph only applies to single family residences.

If there are several malfunctioning on-site systems in an unsewered neighborhood, DNR and DOH will cooperatively promote the installation of a community system.

Other questions requiring the clarification of agency jurisdiction may occur in the future. With continued communication and cooperation, both agencies intend to work out situations with the goal of better serving the public.

SOLID WASTE LANDFILLS

Characterization

Solid waste landfills fall into four categories:

1. Sanitary landfills - municipal and commercial solid waste
2. Demolition landfills - building construction and demolition waste
3. Special Waste landfills - wastes which require special handling - such as foundry sand, wastewater and drinking water sludge, and ash from wastewater sludge incineration
4. Utility Waste Landfills - Fly and bottom ash from coal fired utility boilers

There are currently 36 active landfills (24 sanitary, 4 demolition, 3 special waste, 5 utility) accepting waste in Missouri. Missourians generate trash, including industrial waste, at a rate of approximately 7.9 million tons per year and dispose of 5.5 million tons in landfills. Costs for landfilling are approximately \$27.50 per ton and rising. Alternative waste management options, such as composting and recycling, have increasingly become important components of solid waste management.

In 1989, there were only 4 large-scale yard waste composting facilities in the state. In 1996, there were 97 sites. This exponential growth in the number of composting facilities in the state is primarily the result of yard waste being banned from landfills effective January 1, 1992. The yard waste ban has successfully reduced the amount of waste being disposed of in landfills. There is also a growing interest in composting and co-composting other organic materials such as food waste, wood waste, and paper because of the success that yard waste composting has enjoyed. A processing permit from the Solid Waste Management Program (SWMP) is not required for yard waste composting but may be required for other organic material composting.

Recycling has also increased dramatically during the 1990's. The number of communities with access to recycling services rose from 47 in 1989 to 358 in 1996. Recycling drop-off sites and recycling processing centers that only take source-separated recyclables do not require a solid waste processing permit. Because many of these recycling centers store material outside where it may come in contact with the elements, they may be required to have a state operating permit, issued by the Water Pollution Control Program, to discharge stormwater.

No matter which waste management option is used, properly disposing of our trash is neither inexpensive nor without potential nonpoint source (NPS) problems; the public ultimately bears the costs of disposal and related environmental protection. A 1999 report published by DNR, entitled "The State of Garbage in Missouri" can be viewed at the following link:

<http://www.dnr.mo.gov/oac/pub2072.pdf>

Potential NPS Problems

Leachate entering groundwater and uncontrolled runoff are potential NPS problems associated with solid waste management. Current design requirements for the expansion of existing landfills and for establishing new landfills help prevent leachate problems. However, older landfills that were not constructed under these stricter design requirements pose the most likely source of leachate NPS pollution. Efforts to minimize leachate generation at these older landfills may include a cap placed on the landfill at closure to prevent stormwater infiltration into the

wastes and use of dense stands of vegetation, berms, diversion channels, catchment basins, etc., to manage stormwater run-off and run-on. However, most of these landfills ceased accepting waste years ago and many were not properly closed. Most have no post-closure requirements or financial assurance instruments to address leachate problems if they arise. Many have no viable responsible party.

Illegal dumps - uncontrolled and unpermitted dump sites - are primarily an aesthetic problem with some potential for NPS pollution. Because such dump sites are frequently ravines, stream banks, roadside ditches or sinkholes, substances which have been carelessly discarded may find their way into waters of the state. The extent of water pollution from illegal dumps is not documented.

Regulatory Authority

Missouri DNR's SWMP closely regulates solid waste disposal activities in order to prevent the occurrence of significant problems resulting from landfilling waste (RSMo 260.200-260.345, 10 CSR 80 1.010-11.010). The entire set of solid waste regulations can be viewed at the following website: <http://www.dnr.mo.gov/alpd/swmp/laws/rules.htm>

Requirements for Existing Sanitary Landfills

- A. Composite liner - A liner of a landfill consisting of a soil component and a geomembrane component. The soil component has a hydraulic conductivity equal to or less than 1×10^{-7} cm/sec. The intimate contact between these two liners retards the migration of leachate through the liners into the groundwater.
- B. Leachate collection system - A permeable layer placed below the waste deposit and above the composite liner that drains the leachate from the landfill to prevent it from migrating through the liner into the groundwater.
- C. Run-on control - This control is primarily a set of ditches and berms that prevent stormwater from getting into the waste deposits.
- D. Run-off control - This control is also primarily a set of ditches and berms that prevent water that comes in contact with the waste deposit from getting into the stormwater drainage systems.
- E. Erosion control - The best erosion control is a hardy stand of vegetation. Terraces, rip-rapped ditches and other devices are used in combination with the vegetative cover to control erosion on a site.
- F. Landfill gas control - Landfill gases, primarily methane and carbon dioxide, are produced by decomposing waste. The predominant gas targeted for control is methane. New federal regulations require the control of Non-Methane Organic Compounds (NMOC) by the collection and burning of methane gas. Landfill gas has the potential to degrade groundwater, and methane poses a serious human health threat of explosion or asphyxiation if it accumulates in confined spaces.
- G. Groundwater monitoring - Baseline data is required prior to operation and semi-annual monitoring must be performed to verify that leachate is not migrating through the landfill's liner into the groundwater.
- H. Operator training - A certified solid waste technician must be on staff to make sure that the landfill is operating in accordance with regulatory requirements.

- I. Financial responsibility - A corporation owning and/or running a landfill must show that they have the financial capability to close the site and care for it during a post-closure care period of thirty years.
- J. Stormwater and land disturbance permits - State operating permits are required to discharge stormwater from the landfill property. These permits require specific erosion controls on areas of the landfill and borrow area(s).

Recommendations

Missouri's regulatory approach seems to be working well for active and recently closed facilities. Existing regulations have been revised to reflect changes in state statutes and federal regulations. Research has provided additional understanding of contaminant transport and effects on the environment. Regulations on stormwater and land disturbances have further reduced the potential for problems from surface water discharges to receiving streams and water bodies at active facilities.

There are over one hundred and fifty older landfills scattered throughout the state that don't have adequate funding to correct environmental problems. These older landfills were not constructed or operated like the modern subtitle D sanitary landfills we have today. The presence of these older landfills poses an unknown impact to the water resources of this state. No statewide assessment has been conducted; however, it is very possible that they are contributing leachate contamination to both surface and subsurface water.

The DNR's Solid Waste Management Program is currently evaluating the feasibility of conducting a study of these sites to determine potential and documented public health and safety problems, as well as environmental impacts such as NPS pollution. The ultimate goal of the study would be to promote and establish a solid waste remedial fund which can be used to take corrective action at these sites where needed, and where no responsible party is able to adequately respond.

HAZARDOUS WASTE

Characterization

The manufacture of many products that make life easier, safer, or more pleasant results in the generation of hazardous wastes. By Missouri law, hazardous waste is any waste or combination of wastes, which...may cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness, or pose a present or potential threat to the health of humans or the environment. It includes wastes that are ignitable, corrosive, reactive, toxic or are listed as a hazardous waste in state or federal regulations. Some wastes, which are not found on the lists, may still be regulated as hazardous waste because they exhibit one of the four characteristics of being ignitable, corrosive, reactive, or toxic. Currently in Missouri there are 20,313 active and inactive registered hazardous waste generators, which includes out-of-state generators; 383 licensed transporters; 34 permitted treatment, storage, or disposal (TSD) facilities, 34 interim status TSDs, and 30 closed facilities. All permitted hazardous waste landfills, storage facilities, and incinerators are required to have stormwater permits.

Regulatory Authority

The Department of Natural Resources' Hazardous Waste Program is charged with protecting human health and the environment from possible threats posed by hazardous waste. To accomplish this goal, the program encourages the reduction of hazardous waste generation, regulates management of hazardous waste and oversees the cleanup of hazardous waste contamination in Missouri. The Missouri Hazardous Waste Law is in the Revised Statutes of Missouri (RSMo), Sections 260.003 to 260.575 <http://www.moga.state.mo.us/STATUTES/C260.HTM> and the Code of State Regulations, Title 10, Division 25 (10 CSR 25).

In 1995, responsibility for regulation of underground storage tanks and leaking underground storage tanks was added to the Hazardous Waste Program. The Program now regulates the management of underground storage tanks and administers the Underground Storage Tank Insurance Fund and oversees the cleanup of contamination in accordance with 319.100 through 319.139 RSMo.

The U.S. Environmental Protection Agency (EPA) has recognized the authority of the state to execute aspects of many federal laws including the following:

Resource Conservation and Recovery Act (RCRA) - regulates the “cradle to grave” handling of hazardous waste from generation to recycling, energy recovery, treatment or final disposal and mandates corrective action at hazardous waste management facilities.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) - also known as Superfund, oversees the cleanup of hazardous waste contamination.

Toxic Substances Control Act (TSCA) - regulates handling and disposal of many hazardous substances. The Hazardous Waste Program is authorized under TSCA to conduct compliance inspections for polychlorinated biphenyls (PCBs), and 10 CSR (Code of State Regulations) 25, Chapter 13 regulates proper transportation and disposal of PCBs.

Federal Facility Compliance Act (FFCA) - Requires federal entities to be subject to RCRA. This act also requires the U.S. Department of Energy to develop treatment technology for wastes that are both hazardous and radioactive, known as “mixed wastes.”

Potential NPS Impacts

Spills or releases of hazardous waste or substances do occur. Transportation accidents, pipeline breaks, fires or other disasters have allowed hazardous waste pollutants to enter waters of the state. During the Fiscal Year 2003, the DNR's Environmental Services Program (ESP), Environmental Emergency Response (ERR) Section received a total of 3,851 calls reporting releases of hazardous substances. This number of incident reports is an eleven ~~nine~~ percent increase from the number of calls reported during Fiscal Year 2002. ERR staff responded on-site to approximately 700 of those reported incidents.

In Fiscal Year 2003, methamphetamine lab seizures accounted for 75% of the incidents reported, petroleum products accounted of 22 percent of the incidents reported. Agricultural chemicals were involved in 1.2% of the incidents reported. PCBs accounted for .23% of the incidents.

while sewage accounted for 1.7% of all calls received. Radiological substances were involved in only 0.29% of all incidents.

If the investigation of an incident reveals leakage to surface or ground water, fumes that may affect the public, bulged containers, and other unstable conditions, the department may declare the situation a hazardous substance emergency. An on-scene coordinator from the department's ESP, EER section will then determine what action is needed to stabilize the site and/or clean it up completely.

Hazardous materials NPS problems from leachate account for very few known water quality problems. Discharges to surface water or from leachate collection systems are designated point sources and addressed accordingly. Leachate entering groundwater may be considered a NPS; however, most problems are limited to pre-regulation landfills. Requirements for the expansion of existing landfills and for establishing of new landfills are designed to help prevent leachate problems.

Promiscuous dumps - uncontrolled and unpermitted dump sites - receiving hazardous materials have some potential for NPS pollution. Because such dump sites are frequently ravines, stream banks, roadside ditches or sinkholes, substances which have been carelessly discarded may find their way into waters of the state. However, the extent of water pollution from promiscuous dumps is not documented.

Recommendations

Missouri's Hazardous Waste Management Law seems to be working well. Existing regulations have been expanded and revised recently to reflect changes in state statutes. Regulations on stormwater runoff at all hazardous waste sites have further reduced any problems of surface water discharges to receiving streams and water bodies.

HYDROLOGIC/HABITAT MODIFICATION

Introduction

Hydromodification is the changing of the natural flow of rivers and streams through channelization, bridges, bank stabilization, cut-off devices, dredging, locks and dams, spillways, and watershed construction. Nonpoint source pollution associated with these activities includes sediment, nutrients, pesticides, various organic pollutants, and some inorganic pollutants associated with acids or metals.

From Webster's, habitat is defined as "the region where a plant or animal naturally grows or lives; native environment." A change in the native environment could result in a modification of the life ordinarily found there.

The watersheds of lakes and streams in urban and agricultural areas are clearly no longer ecologically the same as they were in presettlement days. More than 60 percent of the U.S. land surface is manipulated for human needs (urban development, forests, and agricultural areas) and more than 85 percent of the inland water surface area is artificially controlled. Surface water controls range from fixed weirs to multi-gated dams and extend from small farm ponds and streams to large rivers. Modifications to water bodies can benefit us in numerous ways. Lakes are created and stabilized at levels that provide reliable access for recreational boating and preferred rate of electrical generation. Rivers are maintained at appropriate levels for navigation of commercial barges and ships. Manipulation of water levels offers optimal flood protection and water supply for drinking and irrigation. Waterbody modification also may have detrimental effects on wildlife and other functions of aquatic ecosystems, and wetlands in the littoral zone suffer from either too much or too little water. Modifications may also impact important physical properties of the lakes and streams such as water residence time, water level, velocity, bedload, and basin morphology, are often modified. Dynamic hydrologic cycles are all but eliminated, causing the degradation of plant and animal communities as well as water quality.

Any activity that involves the alteration of waters of the state requires a federal and/or sometimes a state permit. Streams, lakes, reservoirs, and adjacent wetlands are all considered waters of the state. Federal permits, under Section 404 of the Clean Water Act, and subsequent state water quality certification, under Section 401, are required for projects involving the discharge of dredged or fill material into waters of the U.S. or wetlands. Examples of stream and lake alteration activities requiring permits include:

- Mining activities
- dredging, widening, straightening, bank stabilization
- levee construction
- channel relocation
- water diversions or dams
- water withdrawal structures
- floodings, excavating, filling or draining a wetland
- dock, lake wall, boat dock construction

Channelization

It is the nature of streams to flood and change course. Natural parts of this process are erosion of stream banks and deposition of streambed materials elsewhere. However, humans have not historically accepted this, trying to alter streamflow wherever possible. While they are generally trying to reduce flooding or stabilize shifting channels, they generally end up accelerating the natural process of stream dynamics. Flood control efforts such as levee construction and various channel modifications attempt to confine water to the channel during higher flow periods. All of these activities increase the volume and velocity of water within a stream during high flow periods. This increased energy worsens channel erosion and increases rates of bank failure, head-cutting, and down-cutting. In terms of physics, moving water has kinetic energy that will inevitably do work. The faster the water moves the more energy is within the system. The excess material transported by streams under such conditions is deposited at a point downstream where the rate of flow is slowed because of changes in gradient, blockages or other flow restrictions. With the next flow event the material is again carried to another deposition location. This process of erosion continues until flow rates become negligible. Such sediment “plumes” can be observed in the upstream portion of many man-made lakes as well as brackish estuarine areas.

Almost without exception, localized efforts to control the periodic flooding and natural shifting of channels result in the worsening of the very “problems” people try to correct. The more stream management problems are addressed in the context of an entire watershed, and the better we are able to understand and accommodate natural stream processes, the more successful our efforts will be. Channelization can result in an increase in stream bank erosion and erosion in upstream reaches and tributaries. Channelization causes turbidity, temperature increases, changes of dissolved oxygen concentration, reduction of habitat for aquatic life, and loss of wetlands. In Missouri, more than 2,200 stream miles have been degraded or lost due to channelization.

Persons considering any channel modification should address all other alternatives first in order to select the most environmentally favorable solution practicable for the particular situation.

Dredging

Lakes - Lakes are reflections of their watersheds and as such receive sediment inputs from the landscapes they drain. At the point where water from a stream enters a lake the water slows down and the sediment load it is carrying is able to fall out of the water column. Over time the sediment builds up, bringing the lake bottom toward the surface and causing the water to become shallower. This is a natural and slow process in undisturbed watersheds; in developed watersheds the process is very rapid - leading to a lower ability to store water for drinking, irrigation, recreation and habitat. One way that increased sedimentation is dealt with in coves and entire lakes is by dredging.

From a habitat standpoint, if a lake is dredged completely it could take 2 to 3 years for the reestablishment of benthic fish-food organisms. However, if portions of the bottom are left undredged, reestablishment may be almost immediate. Dredging is expensive. In most cases, installment of best management practices in the watershed to protect the lake from sedimentation is economically more feasible as well as less damaging to aquatic life.

Streams - The most prevalent form of dredging in Missouri within streams and rivers is for mining of sand and gravel, navigation, or poor attempts at flood control. See previous subcategory entitled “Sand and Gravel Mining”.

Bridge Construction/Highway Impacts

Highway construction frequently includes bridge construction and, consequently, various levels of disturbance within stream corridors. Clearly we could not drive across even a single county in the state without building bridges, but there are potential problems associated with these conveyances. The potential for downstream streambank erosion resulting from the constriction of the floodway by bridge approaches or the bridge structure should be modeled or otherwise quantified. Any areas that may be subject to accelerated rates of erosion related to projects must be adequately protected to control erosion.

The following items should be considered when constructing bridges:

- Placement of permanent fill materials should not be allowed other than design approved bridge support structures and related bank stabilization materials placed below the high bank. Improperly placed materials could lead to habitat destruction and flow alteration.
- Temporary rock stream crossings, when necessary should be placed downstream of project areas and should be designed to minimize impacts on flow and be built to withstand expected floods. Removal of the temporary crossings should not be accomplished between March 15 and June 15 due to possible interruption of spawning season.
- Clearing of forest cover and development of hard surfaces such as rooftops and pavement increase nonpoint source loading and runoff.
- Altering the channel or otherwise moving the primary stream channel should not be done except for the minimum needed for bridge structure placement. Material should not be pushed against banks as an erosion control method. Gravel is not an effective material for use in streambank stabilization.
- Clearing of vegetation, including both standing and downed timber, should be limited to that which is absolutely necessary for construction of projects. Clearing limits should be specified in the project contract.
- Streambed gradient should not be altered through placement of new or removal of existing natural or manmade grade controls or through compaction of riffles. Upstream pool depth should be monitored and maintained during project construction. If bed material must be removed, even temporarily, appropriate measures should be taken to reduce upstream impacts to bed stability.
- All highway project areas disturbed should be revegetated with native vegetation as soon as possible to minimize erosion. A short-term cover crop should be planted as needed to minimize erosion on exposed soils and mulching should be used as necessary. Bottomland

trees should be planted to ensure long-term stability and restore riparian corridor habitat. Follow-up efforts to ensure adequate revegetation should be required.

- Sediment runoff and soil erosion must be minimized in order to reduce suspended solids, turbidity, and downstream sedimentation that may degrade water quality or habitat and negatively impact aquatic life. BMPs should be installed, monitored, and maintained to control erosion on all disturbed areas.
- All surfaces of any equipment used in waters known or suspected to contain the exotic zebra mussels (e.g. MS, MO rivers) shall be examined and scrubbed thoroughly and allowed to air dry for at least one week prior to use in a MO stream.
- Petroleum products, other chemicals and construction debris associated with bridge construction must be prevented from entering the water or otherwise contaminating the riparian environment, as per state law.

Streambank Stabilization, Destabilization, Removal of Vegetation

Increased sediment delivery resulting from deforestation has increased sedimentation and turbidity in downstream channels, lakes and reservoirs, with attendant loss of capacity for water storage and conveyance, recreational and aesthetic values, and quantity and quality of habitat for fish and wildlife.

When stream or river management actions are taken without recognizing interrelated stream variables such as velocity, depth, width, viscosity, parent material, pool-riffle interval, sinuosity, slope, sediment transport, bed-load transport, and bed form, serious damage can be done to the stream or river environment. Work should not take place without knowing whether the aquatic ecosystem is stable or adjusting to recent changes to the watershed.

Stream and riverine wetlands are often severely altered by incomplete planning. Their hydrologic regimes have been altered by dams, pumping, dikes, channelization, dredging, bank stabilization, and watershed development. Efforts to restore riverine wetlands are complicated by the hydrologic and sediment regime changes typical of most rivers, which make it impossible to return wetlands to their natural condition without massive removal of dams, channelization, and so on. However, there are measures that can be taken for increased water quality protection, fish and wildlife habitat, flood control, and bank stabilization.

The cost of streambank stabilization methods varies greatly. The least expensive techniques are the ones that involve using local materials, such as logs or boulders. Besides financial concerns, the type of stream and land surrounding it will influence what types of restoration techniques are used. Streambanks that have been denuded of vegetation will require replanting. The type of plants used will depend upon soil type, geology, weather conditions of the area, and streambank slope. In areas where vegetation must be established quickly, soil bioengineering techniques may be the desired choice. A good stream restoration practice for one area may not be good for another. For instance, trees in the stream may create severe obstructions in some areas, but in others they may be placed there purposely to create fish and wildlife habitat. Often, stream restoration techniques serve the double purpose of stabilizing streambanks and creating habitat.

In order to find the best solution that will be the least costly in the long run, landowners should seek professional advice about what stream restoration techniques to use.

According to the Riparian Restoration and Streamside Erosion Control Handbook, prevention of streambank erosion problems is less expensive than restoration. Preservation and protection of the natural meanders and the native streamside vegetation community are important to streambank protection. Some practical measures that can protect streambanks from erosion follow:

--Maintain an undisturbed buffer zone at least 100 feet wide on both sides of the stream. This area needs the protection of a permanent vegetative root cover and mat to protect and stabilize the soil. Where adjacent slopes are steep, a wider corridor of woody plants and shrubs is appropriate.

--Restrict the operations of heavy machinery, construction, animal grazing, and other intensive activities within the buffer zone. These activities compact the soil, which decreases infiltration, percolation, and aeration, increases runoff, and thus cause the eventual destruction of plants, soil and habitat.

--Use best management practices for agricultural and forestry activities. In agricultural areas, field tillage should follow best management practices as outlined in other sections of the management plan. Maintain an undisturbed riparian corridor next to the stream. Eliminate livestock access to streambanks. Stock watering areas can be used to limit access and should be stabilized by materials that can withstand trampling.

--Plant vegetation. Where existing vegetation is sparse, planting site-specific native plants can be less expensive, offer higher survival rates and give more protection than ornamental or non-native plants. Native self-maintaining perennial species can be selected and planted.

--Don't straighten channels. People often think that straightening the channel is the quickest and easiest solution to their erosion problem. Past experience has shown that channel straightening will simply change the location and nature of the erosion problem and usually make the problem worse.

With a little effort and within a short time, landowners can successfully implement streambank stabilization and riparian restoration techniques. Nature, given a little assistance, can begin to repair the damage caused by manmade and natural events. This leads to a reduction in tons of soil lost from eroding fields and streambanks, increased wildlife habitat, and better understanding of the importance of aquatic resources by landowners."

Wetlands

Wetlands maintain water quality by trapping, precipitating, transforming, and recycling a number of pollutants such as sediment, nutrients, heavy metals, and organic materials. They have properties of both aquatic and terrestrial ecosystems. One of their most widely valued functions is providing habitat for fish, birds, and other wildlife. More than one-third of the federally

endangered and threatened plants and animals require wetland habitats during some portion of their life cycle.

Their position in the landscape, whether as isolated wetland or floodplains contiguous with rivers and streams, also gives wetlands a major role in storage of floodwater and abatement of flooding. Wetlands intercept storm runoff and release floodwaters gradually to downstream systems. Because it is usually the peak flows that contribute to flood damage, wetlands reduce the impact of flooding. When wetlands are converted to systems that are intolerant of flooding (drained agricultural lands, filled developed lands), their storage capacity decreases and downstream flooding occurs. That flood protection values are real is supported by experiences where flood protective functions have been lost. Along the Mississippi River, constructing levees and draining the floodplain have reduced floodwater storage from an estimated 60 days to 12 days because waters can no longer spread out and be absorbed by the broad floodplain. The results have been annually recurring floods along the lower Mississippi River. As water floods into wetlands from rivers and streams, its velocity decreases, causing an increase in sedimentation. Thus, chemicals adsorbed to sediments are removed from the water and deposited in the wetlands. A variety of anaerobic and aerobic processes function to precipitate or volatilize certain chemicals from the water column. The accumulation of organic peat that is characteristic of many wetlands can ultimately lead to a permanent sink for many chemicals. The high rate of productivity of many wetlands can lead to high rates of mineral uptake by, and accumulation in, plant material with subsequent burial in sediments. Shallow water coupled with the presence of emergent vegetation leads to significant sediment-plant-water exchange.

In Missouri, more than 90% of the wetland habitat base has been lost. In most physical alterations of waterways, the wetland ecosystem is obliterated. Biological, chemical, and physical alterations often occur together, and the result is a cumulative impact that may well exceed the “sum” of the individual disturbances.

Wetlands Mitigation Banking

Under Section 404 of the Clean Water Act, anyone wishing to deposit dredge and fill materials in a wetland must follow a prescribed sequencing process. The first step in the process is to make all attempts to avoid impacts to jurisdictional wetlands, second is to minimize the impacts, and third is to mitigate for wetland impacts. In Missouri, several Wetland Mitigation Banks are currently in use. These banks are areas of land set aside for the restoration or creation of wetlands. If a 404 applicant has exhausted the sequencing process and has no on-site area that can be used to mitigate for the wetland impacts, then the applicant can purchase credits in the wetland bank that can be used as mitigation.

The Natural Resources Conservation Service and the American Farmland Trust along with the U.S. Army Corps of Engineers, Environmental Protection Agency, U.S. Fish and Wildlife Service, Missouri Department of Natural Resources, and Missouri Department of Conservation have approved the first wetland mitigation bank in the nation specifically designed for farming activities. This pilot mitigation bank, located in the “Bootheel” region of southeast Missouri and operational since 1999, has been established to offset impacts associated with the conversion of farmed wetlands (i.e., frequently cropped wetlands that have been altered to improve drainage). Some farmed wetlands have significant functions well beyond their small size, with respect to

flood control, water quality and wildlife habitat. However, most are farmed on a yearly basis and their functions continue to degrade over time. This workable mitigation program continues to benefit producers through increased crop yields while providing environmental benefits through the restoration and permanent protection of wetlands.

Habitat Protection/Restoration Practices

Restoration is possible and the following steps from the Riparian Restoration and Streamside Erosion Control Handbook should help (remember that any activity that involves the alteration of waters of the state requires a federal and possibly a state permit):

Speak to your upstream and downstream neighbors to determine if they too have problems, and if they would participate in a repair project.

Take steps to ensure that soil does not get pushed or washed into the stream. Install and maintain sediment control devices where needed.

If you are doing restoration work start at the upstream end and work your way downstream.

Do not implement measures that restrict the size of the channel. Practices that restrict channel flow can cause flooding or increase erosion.

Do not use materials that can be detrimental to aquatic life such as asphalt for riprap or wood treated with pentachlorophenol (PCP) or creosote.

Keep the stream channel and the banks as natural as possible to maintain habitats for fish, aquatic organisms, birds and animals.

Begin and end all streambank protection projects at stable points along the bank. This may be a point at which the main thrust of the flow is parallel to the bank, or at a stable structure such as a bridge or culvert. This may require cooperative efforts by several landowners.

Divert intensive sources of runoff such as gutter downspouts or street drainage away from the area to be treated, and be sure to include appropriate drainage facilities for this flow.

Make sure you have protected the submerged part of the bank, all the way to the channel bottom, and in some cases where undercutting has occurred, below the bottom. Otherwise the current may undermine the erosion control measures installed.

Be prepared to maintain your project. Inspect the project regularly, particularly after heavy rains and high flows, and make necessary repairs as soon as possible.

Re-establish streambank vegetation and trees using native plants.

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OTHER

MANAGEMENT OF UNDERGROUND STORAGE TANKS

Missouri has records of 37,580 underground storage tanks (USTs). The department has confirmed release of 5,716 tanks; with 4,446 cleanups completed.

Potential NPS Problems

These tanks pose a potential threat of nonpoint pollution to ground and surface waters of the state resulting from releases or leaks from these tanks, associated piping and their daily operations. Further, certain cleanup actions or cleanup technologies may produce discharges to waters of the state and exposure of contaminated soils during cleanup or tank closure poses a potential stormwater pollution threat.

To manage the potential nonpoint source pollution problem from these tanks, the Missouri Department of Natural Resources' Hazardous Waste Program (HWP) has developed and implemented a comprehensive set of preventative and corrective action regulations patterned after federal UST regulations. The HWP also maintains a database of tank sites (both registration of tanks and an inventory of sites with confirmed releases).

Further, the department's Water Pollution Control Program (WPCP) has, in coordination with HWP, developed a series of National Pollutant Discharge Elimination System (NPDES) permits to provide adequate control of nonpoint source pollution when a site has experienced a release and is undergoing either closure or cleanup.

Regulatory Authority

Federal UST regulations were promulgated under the authority of Subtitle I of the Resource Conservation and Recovery Act of 1976 as amended by the Solid Waste Amendments of 1984 and are published at Title 40, Code of Federal Regulations, Part 280. Missouri's regulations are authorized under Sections 319.100 through 319.139 of the Revised Statutes of Missouri and are published at Title 10 of the Code of State Regulations, Division 20, Chapters 10, 11 and 13.

These regulations provide the basis for early detection, reporting, investigation and cleanup of releases, prevention of future releases and financial responsibility requirements for UST cleanups.

A Petroleum Storage Tank Insurance Fund has been established which provides tank owners and operators an option for obtaining insurance coverage to meet their financial responsibility obligation as well as providing a program of remedial coverage for past releases at both current and former petroleum tank sites. Under the remedial program offered by this Fund, investigations and cleanups at these sites have been proceeding.

The agency responsible for implementing the environmental regulations is the HWP. Within the HWP, primary administrative responsibility is assigned to the HWP's Tanks Section, with compliance and enforcement actions handled by the Enforcement Section. The department's

five (5) DEQ Regional Offices, the Environmental Services Program and the Geological Survey & Resource Assessment Division handle field activities. These activities are funded by the federal Leaking Underground Storage Tank Trust Fund as well as by state fees for UST registration and by the state's Petroleum Storage Tank Insurance Fund.

HWP coordinates with WPCP on NPDES permit requirements at these sites. Specific site cleanup proposals (corrective action plans or CAPs) are required to demonstrate compliance by either obtaining an individual NPDES permit or by demonstrating that no permit is required. To streamline permitting, the WPCP, in coordination with HWP, has developed several general permits.

General permit #MO-G94 covers a range of activities associated with USTs that have the potential to produce a discharge of wastewater or stormwater.

General permit #MO-R401 provides for control of discharges from ex-situ, land treatment of petroleum contaminated soils. These land treatments include remediation techniques known as land farming and composting.

General permit #MO-R409 provides for control of in-situ corrective action technologies that are not performed in an aquifer. {Note: in-situ corrective action technologies which involve injection into an aquifer are subject to an individual NPDES permit through the underground injection control (UIC) program.}

Recommendations

The department continues to focus its efforts on implementation of the program as outlined above. In addition, Tanks Section staff are following developments in the field of fuel additives and risk-based corrective action (RBCA) policy.

Development and increased use of fuel additives to gasoline is being driven by Clean Air Act mandates. Ethyl alcohol, methyl alcohol, methyl tertiary butyl ether and tertiary amyl ether are all being used or considered for use as additives to gasoline. These additives may have the potential to change the characteristics of petroleum releases, including concerns over toxicity, mobility and the effectiveness of various cleanup technologies.

ATMOSPHERIC DEPOSITION

Progress Resulting From Clean Air Act Requirements

Provisions of the Clean Air Act require states to monitor ambient air quality for concentrations of “criteria” pollutants. These include, volatile organic compounds, nitrogen oxides (NO_x), sulfur dioxide (SO_x), Fine Particulates, Carbon Monoxide, and Lead (Pb). States are required to develop plans to address situations where monitored values exceed federal standards. Missouri has several areas that have historically exceeded the federal air quality standards. Emission controls are either in place or being planned for in these areas. Controlling these emissions can lead to direct reductions in atmospheric deposition.

Acid gases are a primary concern in atmospheric deposition. The Clean Air Act included requirements for the reduction of SO_x and NO_x emissions, the primary causes of acid rain. To achieve this goal at the lowest cost to society, the program employs both traditional and innovative, market-based approaches for controlling air pollution. In addition, the program encourages energy efficiency and pollution prevention.

Title IV of the Clean Air Act sets as its primary goal the reduction of annual SO₂ emissions by 10 million tons below 1980 levels. To achieve these reductions, the law requires a two-phase tightening of the restrictions placed on fossil fuel-fired power plants. Phase I began in 1995 and affects 263 units at 110 mostly coal-burning electric utility plants located in 21 eastern and midwestern states. An additional 182 units joined Phase I of the program as substitution or compensating units, bringing the total of Phase I affected units to 445. Emissions data indicate that 1995 SO₂ emissions at these units nationwide were reduced by almost 40% below their required level.

Phase II, which begins in the year 2000, tightens the annual emissions limits imposed on these large, higher emitting plants and also sets restrictions on smaller, cleaner plants fired by coal, oil, and gas, encompassing over 2,000 units in all. The program affects existing utility units serving generators with an output capacity of greater than 25 megawatts and all new utility units. The Act also calls for a 2 million ton reduction in NO_x emissions by the year 2000. A significant portion of this reduction will be achieved by coal-fired utility boilers that will be required to install low NO_x burner technologies to meet new emissions standards.

Atmospheric Chemistry

The National Atmospheric Deposition Program has two monitoring sites in Missouri, one in the southeast in Butler County and one in the center of the state in Boone County. Rainfall chemistry data from these two sites are similar, and show typical pH values of about 4.6, nitrate concentrations of about 1-mg/l and ammonia concentrations of about 0.3 mg/l. Since the low pH of rainfall is well buffered by the calcareous glacial till in northern Missouri, and limestone and dolomite rocks in most of southern Missouri, pH in surface and groundwater is usually not a problem. Instream and in-lake nitrate and ammonia levels are somewhat lower than concentrations in rainfall due to uptake by aquatic plants.

Acidification of Waters

The St. Francois Mountains area of southeast Missouri include substantial exposures of igneous rocks that provide little buffering of rainfall, but even in this area of the state, there is usually

enough calcareous rock to buffer stream and lake water. A survey of 35 streams in the St. Francois Mountains area by Missouri DNR in April, 1994, found only two streams, McKenzie and Trace Creeks with pH values less than 7.0. Subsequent data has led to the listing in the 1998 state 305(b) report of 5.5 miles of Trace Creek and 0.5 miles of McKenzie Creek as water quality impaired by low pH. A granite mine may aggravate the problem in McKenzie Creek.

Wylie and Jones (1991) evaluated 103 Missouri lakes for sensitivity to acidification using both total alkalinity and Calcite Saturation Index. Only four lakes, all of which were located in the St. Francois Mountains area, appeared to be acid sensitive by both standards. However, no lakes in the state, including these four, have low pH.

Mercury

Mercury is a toxic element released by both natural and man-made processes. Anthropogenic sources of mercury have increased significantly during the industrial revolution. In the US, coal-fired power plants, municipal and hospital waste incineration, Chlor-alkali plants and other sources emit 150 tons of mercury annually. This is only a small part of the global pool. It is now believed that mercury can circumvent the globe. Therefore, mercury emitted in China, or Japan may particulate in the US. Once mercury is deposited in rainwater, and enters lakes and streams, bacteria can change the inorganic mercury to methyl mercury. In this form, it is available to plants and animals. This form of mercury bioaccumulates up the food chain. Therefore, higher trophic levels are most impacted. Currently 44 states have fish advisories concerning mercury. Missouri has listed over 40 lakes and streams on their 303(d) list for mercury impairment.

The Missouri DNR is working nationally to control mercury emissions. In 2002, the department joined the Mercury Deposition Network and installed a wet deposition monitoring station in Mingo Wildlife area. The department has joined with other states to work towards stronger air emission legislation, and information sharing. Statewide activities that would lessen the amount of mercury in the environment include recycling, product bans, trade-outs, and dental amalgam traps.